



This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

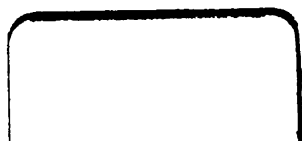
Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

- + *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
- + *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
- + *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
- + *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at <http://books.google.com/>



SCIENCE

A WEEKLY JOURNAL

DEVOTED TO THE ADVANCEMENT OF SCIENCE.

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; J. LE CONTE, Geology; W. M. DAVIS, Physiography; HENRY F. OSBORN, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; J. McKEEN CATTELL, Psychology; DANIEL G. BRINTON, J. W. POWELL, Anthropology.

NEW SERIES. VOLUME IX.

JANUARY-JUNE, 1899.

NEW YORK
THE MACMILLAN COMPANY
1899

**THE NEW ERA PRINTING COMPANY,
41 NORTH QUEEN STREET,
LANCASTER, PA.**

CONTENTS AND INDEX.

N. S. VOL. IX.—JANUARY TO JUNE, 1899.

The Names of Contributors are Printed in Small Capitals.

- ABBE, CLEVELAND, Catalogue for Meteorology, 871
 ADLER, CYRUS, The International Catalogue of Scientific Literature 761, 799
 Age of the Earth, LORD KELVIN, 665, 704; T. C. CHAMBERLIN, 889
 Allen, Alfred H., Commercial Organic Analysis, W. A. NOYES, 63, 818
 ALLEN, J. A., Birds, A. H. EVANS, 647
 American Association for the Advancement of Science, 28, 628, 881
 Amerind—A Designation for the Aboriginal Tribes of the American Hemisphere, 795
 AMES, J. S., Text-book of Physics, Charles S. Hastings and F. E. Beach, 545; Catalogue for Physics, 864
 Anatomists, American, Association, D. S. LAMB, 320
 Angot, Alfred, Météorologie, FRANK WALDO, 743
 Anschütz, R., Organic Chemistry, E. RENOUF, 749
 Anthropological, Section of the American Association, 145; Society of Washington, J. H. MCCORMICK, 218, 590
 Anthropology, Current Notes on, D. G. BRINTON, 37, 117, 156, 185, 227, 266, 299, 338; Advances in Methods of Teaching, FRANZ BOAS, 93
 Arc of Peru, Remasurement of, 916
 Astronomical Notes, WINSLOW UPTON, 36, 224; E. C. PICKERING, 417, 456
 Atomic Weights, FERDINAND G. WIECHMANN, 23; Quarter Century's Progress, F. P. VENABLE, 477
 B., H. C., The Statistical Method in Zoology, 74
 Bailey, L. H., The Principles of Agriculture, ELISHA WILSON MORSE, 328
 Bailey, Solon I., Peruvian Meteorology, R. DeC. WARD, 715
 BARROWS, FRANKLIN W., New York State Science Teachers Association, 811
 BARUS, CARL, The Objective Presentation of Harmonic Motion, 385
 BATHER, F. A., Zoological Bibliography, 154; The Storage of Pamphlets, 720; Some Smithsonian Publications, 775
 BAUER, L. A., Trowbridge's Theory of the Earth's Magnetism, 264
 BEAN, TABLETON H., Fishes of the South Shore of Long Island, 52; Identity of Common and Labrador White Fish, 416
 Beddard, F. E., Structure and Classification of Birds, F. A. LUCAS, 212; Elementary Zoology, CHAS. WRIGHT DODGE, 329
 Bell, Alexander Graham, on the Development by Section of Supernumerary Mammary in Sheep, 637
 BERKEY, CHARLES P., Minnesota Academy of Natural Sciences, 623
 Berry, Arthur, A Short History of Astronomy, DAVID P. TODD, 682
 BESSEY, CHARLES E., 74, 226, 555, 689, 880; The North American Potentillas, per Axel Rydberg, 548; The Evolution of Plants, D. Campbell, 618
 Binet, A., L'Année psychologique, 292
 Biological, Stations of Brittany, JOHN H. GEORGE, 165; Society of Washington, O. F. COOK, 257, 486, 847; Fresh Water Stations of the World, HENRY B. WARD, 497; Text-Books and Teachers, O. F. COOK, 541; Bulletin, 652
 Biology, Section of the N. Y. Acad. of Sci., GARY N. CALKINS, 718; FRANCIS E. LLOYD, 912; of the Great Lakes, JACOB REIGHARD, 906
 BLACKFORD, EUGENE G., Note on the Spawning Season of the Eel, 740
 BLISS, C. B., Section of Psychology and Anthropology, New York Academy of Sciences, 219, 376
 BOAS, FRANZ, Teaching of Anthropology, 93
 BOLTON, H. CARRINGTON, and W. P. CUTTER, Catalogue for Chemistry, 867
 Boston Society of Natural History, SAMUEL HENSHAW, 624
 Botanical Club, Torrey, E. S. BURGESS, 33, 295, 520, 581, 819, 876; of Washington, CHARLES LOUIS POLLARD, 291, 914; of the University of Chicago, 413; Notes, CHARLES E. BESSEY, 74, 226, 555, 689, 880; Gazette, 376, 589, 620
 BOUTWELL, J. M., Geological Conference and Students' Club of Harvard University, 33, 113, 335, 519, 591, 719, 752, 786
 BRIGHAM, A. P., Physical Geography, W. M. Davis and H. W. Snyder, 410
 BRINTON, D. G., Current Notes on Anthropology, 37, 76, 117, 156, 185, 227, 266, 299, 338
 BRITCHEL, H. W., Onondaga Academy, 114, 376
 BROOKS, W. K., Truth and Error, 121; The Wonderful Century, A. R. Wallace, 511
 Brunissure of the Vine, ALBERT F. WOODS, 508
 BUMPUS, H. C., Marine Biological Laboratory, 228
 BURGESS, E. S., Torrey Botanical Club, 33, 295, 520, 591, 819, 876
 Burnside, W., Theory of Groups of Finite Order, F. N. COLE, 106
 Butler, A. W., Birds of Indiana, F. M. C., 66
 C., C. G., Practical Astronomy, W. W. Campbell, 842
 C., F. C., Physical Notes, 116, 378, 493, 555
 C., F. M., Birds of Indiana, A. W. Butler, 66
 C., H. W., Bacteriology, Ferdinand Hueppe, 513
 CAJORI, FLORIAN, Carl Friedrich Gauss and his Children, 697
 CALKINS, GARY N., Biological Section of the New York Academy of Sciences, 718

- CHAMBERLIN, T. C., Lord Kelvin's Address on the Age of the Earth as an Abode fitted for Life, 889
 Campbell, D. H., The Evolution of Plants, CHARLES E. BESSEY, 618
 Campbell, W. W., Astronomy, G. C. C., 842
 Card, Fred. W., Bush Fruits, B. D. HALSTED, 109
 Catalogue, International of Scientific Literature, 187;
 CYRUS ADLER, 761, 799; J. VICTOR CARUS, 825,
 Physics, J. S. AMES, 864, Chemistry, H. CARRINGTON BOLTON, W. P. CUTTER, 867; CLEVELAND ABBE, 871; N. S. SHALEB, 907; JACQUES LOEB, 908
 CATTELL, J. MCKEEN, Degrees in Science in Harvard University, 522
 Cayley, Arthur, Collected Mathematical Papers, GEORGE BRUCE HALSTED, 59
 Chemical, Society of Washington, WILLIAM H. KRUG, 32, 517, 622, 751; Society, American, DURAND WOODMAN, General Meeting, 58; N. Y. Section of, 258, 487, 654, 820, 913; Journal American, 151, 257, 451, 620, 718, 712
 Chemistry, Notes on Inorganic, J. L. H., 71, 155, 185, 266, 297, 337, 457, 595, 623, 652, 656, 688; Physical, Journal of, 151, 293; Organic, The Revival of, H. N. STOKES, 601
 CLARK, WILLIAM BULLOCK, Geology, James D. Dana, 147; Report of Official State Bureaus, 162
 CLEMENT, FREDERIC E., Pflanzengeographie, A. F. W. Schimper, 747
 Climatological Ass. Amer., GUY HINSDALE, 774
 COCKERELL, T. D. A., The Chinch Bug, F. M. Webster, 175; North American Rhopalocera, Henry Skinner, 373; A Date-palm Scale Insect, 417; Color in Nature, Marion J. Newbiggin, 448
 COE, W. R., The Time of Breeding of some Common New England Nemertean, 167
 COLE, F. N., The American Mathematical Society, 57, 322, 684; Theory of Groups of Finite Order, W. Burnside, 106
 Cole, R. S., Photographic Optics, FRANK WALDO, 874
 Collins, Joseph, Faculty of Speech, E. W. F., 745
 Congdon, Ernest, A Qualitative Analysis, W. A. NOYES, 26
 CONKLIN, EDWIN G., Advances in Methods of Teaching Zoology, 81
 COOK, O. F., Biological Society of Washington, 257, 332, 468, 847; Biological Text-books and Teachers, 541
 CRANDALL, CHARLES S., Storing Pamphlets, 115
 CREIGHTON, J. E., The Groundwork of Science, St. George Mivart, 147
 Creighton, J. E., Logic, GEORGE REBEC, 779
 Cummings John, Wm. H. NILES, 24
 CUTTER, W. P., and H. CARRINGTON BOLTON, Catalogue for Chemistry, 867
 D., A. St. C., Notes on Physics, 225, 419, 655, 687
 D., T., The Choice of Elements, 418
 DALL, Wm. H., Zoological Nomenclature, 221
 Dana, James D., Revised Text-book of Geology, W. B. CLARK, 147
 DAVENPORT, CHAS. B., Specific Place Modes, 415
 Davenport, Charles B., Experimental Morphology, T. H. MORGAN, 648
 Davis, W. M., and H. W. Snyder, Physical Geography, ALBERT PERRY BRIGHAM, 410
 DAWSON, GEORGE M., Duplication of Geologic Formation Names, 592
 DAY, WM. S., Section of Astronomy and Physics of the New York Academy of Sciences, 653, 850
 DEAN, BASHFORD, Amer. Morphological Soc., 311, 364; Lamprey Macrophthalmia Chilensis, 740
 DEARBORN, G. V. N., The Origin of Nightmare, 455
 DEGAIRMO, CHARLES, Talks to Teachers on Psychology, William James, 909
 Delage, Ives, L'Année biologique, 292
 Derventer, Ch. van, Physical Chemistry for Beginners, HARRY C. JONES, 750
 Dewar, on Liquid Hydrogen, 914
 DILLER, J. S., Stalactites of Sand, 371; Latest Volcanic Eruptions of the Pacific Coast, 639
 Discussion and Correspondence, 34, 70, 114, 154, 184, 221, 259, 297, 376, 415, 455, 488, 520, 553, 592, 624, 686, 720, 752, 787, 820, 850, 877
 DODGE, CHARLES WRIGHT, Elementary Zoology, Frank E. Beddard, 329
 DODGE, RICHARD E., Rivers of North America, Israel C. Russell, 214; New York Academy of Sciences, 452; Suggestions for Scientific Seminars, 520
 DOOLITTLE, C. L., National Observatory, 471
 Durand, J. P., Taxonomie générale, F. A. L., 150
 DWIGHT, THOMAS, Human Anatomy, Henry Morris, 27
 EASTMAN, C. R., Plastiline, 211; Some New American Fossil Fishes, 642
 Eel, Spawning Season of the, EUGENE G. BLACKFORD, 740; Larval Stage of the THEO. GILL, 820
 EIGENMANN, CARL H., A Case of Convergence, 280
 ELKIN, W. L., National Observatory, 475
 Embouchure, N. A. Indian Flageolets, E. H. HAWLEY, 742
 Entomological Society of Washington, L. O. HOWARD, 181, 413
 EVANS, A. H., Birds, J. A. Allen, 647
 Explosions caused by commonly occurring Substances, CHARLES E. MUNROE, 345
 F., W. H., Industrial Electricity, Henry de Graffigny, 374
 F., W. S., Notes on Physics, 336, 378, 418, 457
 FARRAND, LIVINGSTON, American Psychological Association, 249; Indians of Western Washington, 533
 FARRINGTON, OLIVER C., Moon Model, 35
 Fatigue, Mental, EDWARD THORNDIKE, 712
 FLINT, A. S., Wisconsin Academy of Sciences, 179
 Folwell, A. P., Sewerage, M. M., 64
 Food Adulteration, Senatorial Investigation of, 793
 FOWKE, GERRARD, Archaeological Investigations on the Amoor River, 539
 FRANKLIN, W. S., The Sensation of Motion and its Reversal, 70; Etherion, 297; Fundamental Law of Temperature for Gaseous Celestial Bodies, 594
 FUERTES, E. A., National Observatory, 475
 FULLER, M. L., Rapidity of Sand-plain Growth, 643
 G., J. E., Freezing-point, Boiling-point and Conductivity Methods, Harry C. Jones, 150
 GALLOWAY, B. T., Enzymes as Remedies in Infectious Diseases, 379
 GANONG, W. F., Methods of Teaching Botany, 96; Columbia Meeting of the Society for Plant Morphology and Physiology, 169
 GARDINER, EDW. G., Plymouth, England, and its Marine Biological Laboratory, 488

- Genes, Carl Fiedrich and his Children, FLORIAN CAJORI, 697
- Geological, Conference and Student's Club of Harvard University, J. M. BOUTWELL, 33, 113, 335, 519, 591, 719, 752, 786; Soc. of Amer., J. F. KEMP, 100, 138; Soc. of Washington, Wm. F. MORSELL, 152, 454, 551, 622; Survey, Publications, 177; of Maryland, BAILEY WILLIS, 252; In Alaska, W. F. M., 628; Club, University of Minnesota, F. W. SARDSON, 412; Expedition to the Philippines, W. F. M., 722
- Geologist, American, 111, 517.
- Geology, Journal of, 375, 783, 911; and Mineralogy, Section of the N. Y. Acad. of Sci., ALEXIS A. JULIEN, 719, 818.
- GERBOULD, JOHN H., The Biological Stations of Brittany, 165
- GIDDINGS, FRANKLIN H., The Psychology of Society, 16
- GILL, THEO., Larval Stage of the Eel, 820
- GORDON, REGINALD, Section of Astronomy and Physics of the N. Y. Acad. of Sci., 219, 488
- GRAFFIGNY, HENRY DE, Industrial Electricity, W. H. F., 374
- GROOS, KARL, Die Spiele der Menschen, HIRAM M. STANLEY, 619
- GUYER, MICHAEL F., Ovarian Structure in an Abnormal Pigeon, 876
- H. J. L., Notes on Inorganic Chemistry, 71, 155, 185, 286, 297, 337, 457, 593, 623, 652, 656, 688
- HAGEN, J. G., Atlas of Variable Stars, 29
- HAGUE, ARNOLD, The Early Tertiary Volcanoes of the Abasco Range, 425
- HALL, ASAPH, National Observatory, 468
- HALLOCK, WILLIAM, Kirchhoff's Principle, 210; Reception and Exhibition of the N. Y. Acad. of Sci., 616
- HALSTED, B. D., Bush Fruits, Fred. W. Card, 109
- HALSTED, GEORGE BRUCE, Mathematical Papers, 59; La vie sur les hauts plateaux, A. L. Herrera and D. V. Lope, 255; Sophus Lie, 447; N. I. Lobatschefski, 813
- HARSHBERGER, JOHN W., Transmitted Characteristics in a White Angora Cat, 554
- HASTINGS, CHARLES S., and F. E. BEACH, Text-Book of General Physics, J. S. AMES, 545
- HAWLEY, E. H., Embouchure in N. A. Indian Flageolets, 742
- HAY, O. P., Fossil Vertebrates, 593
- HELLMANN G., Wetter Prognosen, A. L. ROTCH, 910
- HELMHOLTZ, HERMANN VON, Brain of, 557
- HENSHAW, SAMUEL, Boston Society of Natural History, 624
- HERRERA, A. L., and D. V. Lope, La vie sur les hauts plateaux, GEORGE BRUCE HALSTED, 255
- HILL, ROBERT T., Cuba and Porto Rico, W. J. M., 65; and T. W., Vaughan, The Lower Cretaceous Gryphaeas of the Texas Region, F. W. SIMONDS, 110; Geology of the Edwards Plateau and Rio Grande Plain, FREDERIC W. SIMONDS, 481
- HINSDALE, GUY, Medical Climatology, S. EDWIN SOLLY, 485; Amer. Climatological Association, 774
- HOBS, WM. H., Science Club of the University of Wisconsin, 875
- HOLLAND, W. J., The Butterfly Book, SAMUEL H. SCUDDER, 66
- HOLMAN, SILAS W., Matter, Energy, Force and Work, 154
- HOLMAN, SILAS W., Matter, Energy, Force and Work, T. C. M., 24
- HOWARD, L. O., Entomological Soc. of Washington, 181, 413; Economic Status of Insects, 233
- HUEPPE, FERDINAND, Principles of Bacteriology, H. W. C., 513
- HUNTINGTON, GEO. S., Teaching of Anatomy, 85
- JAMES, WILLIAM, Lehmann and Hansen on Telepathy, 654; Telepathy Once More, 752
- JAMES, WILLIAM, Talks to Teachers on Psychology, CHARLES DEGARMO, 909
- JESUP, NORTH PACIFIC EXPEDITION, L. FARRAND, 533; HARLAN I. SMITH, 535; GEORGE FOWKE, 539, 732
- JOHNSON, ROSWELL, H., Two-headed snakes, 625
- JONES, HARRY C., Physical Chemistry, J. L. R. MORGAN, 717; Physical Chemistry Ch. van Der-venter, 750
- JONES, HARRY C., Freezing Point, Boiling Point and Conductivity Methods, J. E. G., 150
- JORDAN, DAVID STARR, A Sage in Science, 529; A Posthum Phantom, a Study in the Spontaneous Activity of Shadows, 674
- JORDAN, EDWIN O., Examination of Water, WILLIAM P. MASON, 548
- JUDD, CHAS. H., Sub-Section of Anthropology and Psychology of the N. Y. Acad. of Sci., 553, 685
- JUDD, SYLVESTER D., Birds as Weed Destroyers, 905
- JULIEN, ALEXIS A., Section of Geology and Mineralogy of the N. Y. Acad. of Sci., 719, 818
- KEELER, JAMES E., National Observatory, 476
- KELVIN, LORD, The Age of the Earth, 665, 704
- KELVIN, LORD, Address on the Age of the Earth, PROFESSOR T. C. CHAMBERLIN, 889
- KEMP, J. F., Geological Society of America, 100, 138
- KEYSER, C. J., Infinitesimal Analysis, W. B. SMITH, 844
- KROEBER, A. L., Anthropological Section of the American Association, 145
- KRUG, WILLIAM H., Chemical Society of Washington, 32, 333, 517, 622, 751
- L., F. A., The New York Zoological Park, 73; Taxonomie, J. P. DURAND, 150; Neomylodon Listai, 459
- LAMB, D. S., Association of Amer. Anatomists, 320
- LAWRENCE, RALPH E., Mercury Pump, 510
- LEE, FREDERIC S., Amer. Physiological Society, 286; Laboratory Exercises in Anatomy and Physiology, J. E. PEABODY, 331
- Leland Stanford Jr. University, 916
- Leroux, Ernest, Codex Borbonicus, M. H. SAVILLE, 746
- Lie, Sophus, GEORGE BRUCE HALSTED, 447
- LITTLEHALES, G. W., The Prospective Place of the Solar Azimuth Tables in the Problem of Accelerating Ocean Transit, 640
- LLOYD, FRANCIS E., Section of Biology of the N. Y. Acad. of Sci., 913
- Lobatschefski, Nikolai Ivanovitch, GEORGE BRUCE HALSTED, 813
- LOCKWOOD, M. H., and E. B. WHEELER, On the Action of the Coherer, 624
- LOCY, WM. A., Northwestern University Science Club, 31
- LOEB, JACQUES, Catalogue for Physiology, 908
- LOEW, OSCAR, What is the Cause of the so-called Tobacco Fermentation, 376

- Loew, Oscar, Die chemische Energie der Lebenden Zellen, ALBERT F. WOODS, 409
- LORING, J. ALDEN, Virginia Opossum, 71
- LUCAS, F. A., Structure and Classification of Birds, F. E. Beddard, 212; Nomenclature of the Hyoid in Birds, 323; Biological Society of Washington, 785
- LUSK, GRAHAM, Physiology, E. A. Schäfer, 291
- M., F., Sanitary Engineering, Mansfield Merriman, 109
- M. M., Sewerage, A. P. Folwell, 64
- M., T. C., Metric System, 377; Matter, Energy, Force and Work, Silas W. Holman, 24
- M., W. F., Geological Survey Work in Alaska, 628; Expedition to the Philippines, 722
- M., W. J., Cuba and Porto Rico, Robert T. Hill, 65
- MACDOUGAL, D. T., Physiology, Max Verworn, 650
- MACFARLANE, ALEXANDER, Algebra, A. N. Whitehead, 324
- MACLOSKE, GEORGE, Physiological Osmosis, 206; Osmotic Solutions, 554
- Marine Biological Laboratory, H. C. BUMPUS, 228; of Plymouth, Eng., EDW. G. GARDINER, 488; A New, HUGH M. SMITH, 658; Wood's Holl, 721
- MARLATT, C. L., Some Common Sources of Error in recent Work on Coccidæ, 835
- Marr, J. E., Stratigraphical Geology, HENRY S. WILLIAMS, 547
- Mars, the Planet, G. SOTTAPARELLI, 633
- Marsh, Othniel Charles, J. L. WORTMAN, 561
- Mason, William P., The Examination of Water, EDWIN O. JORDAN, 548
- Mathematical Society, The American, F. N. COLE, 57, 322; Transactions of, 375; Bulletin, 412, 450, 751
- MCCLENAHAN, HOWARD, On the Wehnelt Current Breaker, 753
- MCCORMICK, J. H., Anthropological Society of Washington, 218, 590
- MENDENHALL, T. C., National Observatory, 469
- MERCER, HENRY C., Men of Science and Anti-Vivisection, 221
- Mercury Pump, Ralph R. Lawrence, 510
- MERRIAM, C. HART, Zone Temperatures, 116
- Merriman, Mansfield, Sanitary Engineering, M., 109
- MERRITT, ERNEST, The Discharge of Electricity through Gases, J. J. Thomson, 289
- Meteorology, Current Notes on, R. DE C. WARD, 72, 116, 298, 458, 627, 657, 787, 878; Catalogue of, CLEVELAND ABBE, 871
- Minnesota Academy, CHARLES P. BERKEY, 623
- MINOT, CHARLES S., Anatomy and Histology of the Mouth and Teeth, J. Norman Broomall, 216
- Mivart, St. George, The Groundwork of Science, J. E. CREIGHTON, 147
- Morgan, J. L. R., Elements of Physical Chemistry, HARRY C. JONES, 717
- MORGAN, T. H., Experimental Morphology, Charles B. Davenport, 648
- Morris, Henry, Human Anatomy, THOMAS DWIGHT, 27
- MORSE, ELISHA WILSON, The Principles of Agriculture, L. H. Bailey, 328
- MORSELL, W. F., Geological Society of Washington, 152, 454, 551, 622
- MUNROE, CHARLES E., Explosions Caused by Commonly Occurring Substances, 345
- MÜNSTERBERG, HUGO, Methods of Teaching Psychology, 91; Physiological Basis of Mental Life, 442
- MYERS, G. W., National Observatory, 474
- National Academy of Sciences, 621
- Newbiggin, Marion J., Color in Nature, T. D. A. COCKERELL, 448
- NEWCOMB, SIMON, National Observatory, 467
- Newcomb, Professor Simon, 851
- NEWELL, W. W., American Folk-lore Society, 173
- Newth, G. S., Quantitative and Qualitative Chemical Analysis, HENRY FAY, 176
- New York Acad. of Sci., Section of Astronomy and Physics, W. S. DAY, 653, 850; R. GORDON, 219, 488; of Psychology and Anthropology, C. B. BLISS, 219, 376; C. H. JUDD, 553, 685; of Biology, G. N. CALKINS, 718; FRANCIS E. LLOYD, 912; of Geology and Mineralogy, A. A. JULIEN, 719, 818; Annual Meeting R. E. DODGE, 452; Reception and Exhibition, WILLIAM HALLOCK, 618
- NILES, WM. H., John Cummings, 24
- NOLAN, EDWARD J., Philadelphia Academy of Natural Sciences, 68, 181, 336
- NORRIS, JAMES F., The Spirit of Organic Chemistry, Arthur Lachman, 817
- NOYES, W. A., Qualitative Analysis, Ernest A. Congdon, 26; Commercial Organic Analysis, Alfred H. Allen, 63, 818; Industrial Chemistry, 160
- O., C. A., Defective Eyesight, ST. JOHN ROOSA, 846
- O., H. F., The Removal of Dr. Wortman to the Carnegie Museum, 755
- Observatory, The United States Naval, A. N. SKINNER, 1, 857; A National, 465; Discussion of a, 467; SIMON NEWCOMB, 468; ASAPH HALL, 468; C. A. YOUNG, 468; T. C. MENDENHALL, 469; R. S. WOODWARD, 470; C. L. DOOLITTLE, 471; W. H. PICKERING, 472; ARTHUR SEARLE, 472; FRANK W. VERY, 473; DAVID P. TODD, 473; G. W. MYERS, 474; E. A. FUERTES, 475; W. L. ELKIN, 475; JAMES E. KEELER, 476
- Opossum, Virginia, J. ALDEN LORING, 71
- OSBORN, HENRY F., Frontal Horn on Aceratherium Incisivum, 161
- OSBORN, H. L., A Remarkable Sun-dog, 521
- OSBURN, R. C., Ohio Academy of Science, 180
- P., T. S., Wild Animals I have known, Ernest Seton Thompson, 26
- PATRICK, G. T. W., Degeneracy, Eugene S. Talbot, 372
- Patten, Simon N., The Development of English Thought, R. M. WENLEY, 713
- PEARSON, KARL, Reproductive Selection, 283
- Philadelphia, Academy of Natural Sciences, EDWARD J. NOLAN, 68; Exposition of 1900, 659
- Philosophical Society of Washington, E. D. PRESTON, 218, 296, 454, 621, 652, 686, 846
- Physical Society, American, A. G. WEBSTER, 784
- Physics, Notes on, 116, 225, 336, 377, 378, 418, 458, 493, 555, 655, 687; Club of New York, A. T. SEYMOUR, 553; Catalogue for, J. S. AMES, 864
- Physiological, Society, American, The N. Y. Meeting of, FREDERIC S. LEE, 286; Basis of Mental Life, HUGO MÜNSTERBERG, 442
- PICKERING, E. C., Astronomical Notes, 417, 456
- PICKERING, W. H., National Observatory, 47

- PIKEPONT, JAMES, *Analytic Functions*, J. Harkness and F. Morley, 586
- Plant Morphology, and Physiology, The Society of, W. F. GANONG, 169
- POLLARD, CHARLES LOUIS, Botanical Club of Washington, 294, 487, 652, 914
- PORTER, WM. T., *Methods of Teaching Physiology*, 87
- POWELL, J. W., Reply to Critics, 259
- Powell, J. W., Truth and Error, W. K. BROOKS, 121; LESTER F. WARD, 126
- PRESTON, E. D., Philosophical Society of Washington, 218, 621, 296, 454, 652, 686, 846; Geodetic Operations in the United States, 305
- PRITCHETT, HENRY S., *Magnetic Survey of the United States by the Coast and Geodetic Survey*, 729
- Pumas of Western United States, WITMER STONE, 34
- RAMALEY, FRANCIS, Scientific Society of the University of Colorado, 720
- RAMBAY, WILLIAM, *The Recently Discovered Gases and their Relation to the Periodic Law*, 273
- Rauh, F., *La psychologie des sentiments*, H. M. STANLEY, 683
- REBEC, GEORGE, *Introductory Logic*, 779
- REIGHARD, JACOB, *Biology of the Great Lakes*, 906
- RENOUF, E., *Organic Chemistry*, R. Anschütz, 749
- ROOSA, ST. JOHN, *Defective Eyesight*, C. A. O., 846
- ROTCH, A. L., *Wetterprognosen und Wetterberichte*, G. Hellmann, 910
- Russell, Israel C., *Rivers of North America*, RICHARD E. DODGE, 214
- SAFFORD, TRUMAN HENRY, *On the Total Solar Eclipse of May 28, 1900*, 115
- SARDESON, F. W., Geological Club of the University of Minnesota, 412
- SAVILLE, M. H., *Codex Borbonicus*, Ernest Leroux, 746
- Schäfer, E. A., *Physiology*, GRAHAM LUSK, 291
- SCHIAPARELLI, G., *Observations of Planet Mars*, 633
- Schimper, A. F. W., *Pflanzengeographie*, FREDERIC E. CLEMENTS, 747
- Schnabel, Carl, *Metalurgy*, J. STRUTHERS, 588
- Science, Nebraska Academy of, 29; Club of Northwestern University, WM. A. LOOY, 31; and politics, S. W. WILLISTON, 114; Academy of St. Louis, WILLIAM TRELEASE, 114, 220, 415, 488, 624, 720, 786; Onondaga Academy of, H. W. BRITCHER, 114; Work, 152; Natural, 152; Ohio Academy of, R. C. OSBURN, 180; American Journal of, 517, 652; Degrees in, at Harvard University, J. MCKEEN CATTELL, 522; A Sage in, DAVID STARR JORDAN, 529; American Association for the Advancement of, 628; Abstracts, 784; Teachers Association of N. Y. State, FRANKLIN W. BARROWS, 811; Club of the University of Wisconsin, WM. H. HOBBS, 875.
- Sciences, Natural, Philadelphia Academy of, EDWARD J. NOLAN, 68; Minnesota Academy of, CHARLES P. BERRY, 623; Arts and Letters, Wisconsin Academy of, A. S. FLINT, 179; Texas Academy of, FREDERIC W. SIMONDS, 217; National Academy of, 621; New York Academy of; Section of Astronomy and Physics, R. GORDON, 219, 488; W. S. DAY, 653, 850; of Psychology and Anthropology, C. B. BLISS, 219, 376; C. H. JUDD, 553, 685; of Geology and Mineralogy, A. A. JULIEN, 719, 818; of Biology, G. N. CALKINS, 718; Annual Meeting, RICHARD E. DODGE, 452; Reception and Exhibition, WILLIAM HALLOCK, 616
- Scientific, Books, 24, 59, 106, 147, 174, 212, 252, 289, 324, 372, 409, 448, 481, 511, 545, 586, 618, 682, 713, 743, 755, 813, 842, 872, 909; Journals and Articles, 29, 67, 111, 151, 178, 217, 257, 293, 375, 450, 485, 517, 549, 589, 620, 718, 750, 783, 911; Notes and News, 38, 76, 118, 157, 188, 267, 300, 339, 379, 420, 460, 494, 524, 557, 597, 628, 692, 724, 755, 788, 820, 851, 883, 917; Seminars and Conferences, RICHARD E. DODGE, 520; Appointments under the Government, 523; Alliance of New York, 550, 629; Society of the University of Colorado, FRANCIS RAMALEY, 720
- SCRIPTURE, E. W., *The Anæsthetic Effects of a Sinusoidal Current of High Frequency*, 377; *Color-Weakness and Color-Blindness*, 771; *Cerebral Light*, 850; *Arousal of Instinct by Taste*, 878
- SCUDDER, SAMUEL H., *The Butterfly Book*, W. J. Holland, 66
- SEARLE, ARTHUR, National Observatory, 472
- SEE, T. J. J., *An Extension of Helmholtz's Theory of the Heat of the Sun*, 737
- SEYMOUR, A. T., Physics Club of New York, 553
- SHALER, N. S., *Geology and Geography in the International Catalogue of Scientific Literature*, 907
- SHARPE, B. F., *A Double Instrument and a Double Method for the Measurement of Sound*, 808
- SIMONDS, F. W., *The Lower Cretaceous Gryphæas of the Texas Region*, 110; *Texas Academy of Sciences*, 217; *Geology of the Edwards Plateau and Rio Grande Plain*, Robt. T. Hill and W. T. Vaughan, 481
- SKINNER, A. N., The U. S. Naval Observatory, 1
- SMITH, EUGENE A., Alabama Industrial and Scientific Society, 296
- SMITH, HARLAN I., *Collections of the Provincial Museum of Victoria, British Columbia*, 156; *Archæological Investigations on the North Pacific Coast of America*, 535
- SMITH, HUGH M., *A New Marine Biological Laboratory*, 658; *Exploring Expedition to the M.-d-Pacific Ocean*, 796
- Smith, W. B., *Infinitesimal Analysis*, C. J. KEYSER, 844
- Societies and Academies, 29, 68, 112, 152, 179, 217, 257, 294, 332, 376, 412, 452, 486, 517, 550, 590, 621, 684, 718, 751, 784, 818, 847, 875, 912
- Solly, S. Edwin, *Medical Climatology*, GUY HINGDALE, 485
- Solutions, M. A. WILLCOX, 455; Osmotic, G. MACCLOCKIE, 554
- Sound, A Double Instrument and a Double Method for the Measurement of, B. F. SHARPE, 808
- Specific Place Modes, CHARLES B. DAVENPORT, 415
- STANLEY, HIRAM M., *Artificial Dreams*, 263; *Evolution of Modesty*, 553; *Die Spiele der Menschen*, 619; *La psychologie des sentiments*, 683; *Totemism*, 877
- Steam-Engine, Theory of the, R. H. THURSTON, 659
- 'Steam-gas,' R. H. THURSTON, 753
- STEVENS, W. LE CONTE, *Physics—Sound*, J. H. Poynting and J. J. Thomson, 872
- STEVENSON, J. J., Our Society, 41
- STILES, CH. WARDELL, *Tuberculosis Conference*, 491
- St. Louis Academy of Science, WILLIAM TRELEASE, 114, 220, 415, 488, 624, 720, 786
- STOKES, H. N., *Revival of Inorganic Chemistry*, 601

- STONE, WITMER, Pumas of the Western United States, 34
- STREUTHERS, J., Handbook of Metallurgy, Carl Schnabel, 588
- T., E. W., Faculty of Speech, Joseph Collins, 745
- T., R. H., Anti-Friction Alloys, 247; Automatic Ship Propulsion, 915
- Talbot, Eugene S., Degeneracy, G. T. W. PATRICK, 372
- Thompson, Ernest Seton, Wild Animals I have Known, T. S. P., 26
- THOMPSON, M. T., Breeding of Animals at Wood's Hole during the Month of September, 1898, 581
- Thomson, J. J., The Discharge of Electricity through Gases, ERNEST MERRITT, 289
- THORNDIKE, EDWARD, The Dawn of Reason, James Weir, 450; Mental Fatigue, 712; The Mental Fatigue due to School Work, 862
- Thorp, Frank, Industrial Chemistry, W. A. NOYES, 150
- THURSTON, R. H., The Suppression of Smoke, 55; Professional Schools vs. Business, 207; Engineering and the Professions in Education, 407; Agricultural Electro-technics, 480; Economics in Manufactures, 583; Theory of the Steam Engine, 659; Thermodynamic Action of Steam Gas, 753
- TITCHENER, E. B., Lehmann and Hansen on 'the Telepathic Problem,' 36; Professor James on Telepathy, 686; The Telepathic question, 787
- TODD, DAVID P., Discussion of a National Observatory, 473; A Short History of Astronomy, Arthur Berry, 682
- Torrey Botanical Club, E. S. BURGESS, 33, 295, 520, 591, 819, 876
- TRELEASE, WILLIAM, Academy of Science of St. Louis, 114, 220, 415, 488, 624, 720, 786
- Trowbridge's Theory of the Earth's Magnetism, L. A. BAUER, 264; JOHN TROWBRIDGE, 265
- TRUE, A. C., Agricultural Experiment Stations, 199; The Scientific Study of Irrigation, 798
- University and Educational News, 40, 80, 120, 160, 192, 271, 304, 341, 383, 424, 464, 496, 528, 559, 600, 631, 695, 728, 759, 791, 824, 856, 887
- UPTON, WINSLOW, Astronomical Notes, 36, 224, 492; The Storing of Pamphlets, 184
- VENABLE, F. P., Atomic Weights, A Quarter Century's Progress, 477
- Verworn, Max, General Physiology, D. T. MacDougal, 650
- VERY, FRANK, W., National Observatory, 473
- WALDO, FRANK, Météorologie, Alfred Angot, 743; Photographie Optique, R. S. Cole, 874
- Wallace, A. R., The Wonderful Century, W. K. Brooks, 511
- WARD, HENRY B., The Fresh-water Biological Stations of the World, 497
- WARD, LESTER F., Truth and Error, 126
- WARD, R. DEC., Current Notes on Meteorology, 72, 116, 298, 458, 627, 657, 787, 878; Peruvian Meteorology, Solon I. Bailey, 715
- WASHBURN, F. L., Hermaphroditism in *Ostrea Lurida*, 478
- Webster, F. M., The Chinch Bug, T. D. A. COCKRELL, 175
- WEEKS, F. B., Duplication of Geologic Formation names, 490, 625
- Weir, James, The Dawn of Reason, EDWARD THORNDIKE, 450
- WENLEY, R. M., The Development of English Thought, Simon N. Patten, 713
- Whitehead, A. N., A Treatise on Universal Algebra, ALEXANDER MACFARLANE, 324
- WHITMAN, FRANK P., On the Brightness of Pigments by Oblique Vision, 734
- WIECHMANN, FERDINAND, G., Atomic Weights, 23
- WILDER, BURT G., Some Misapprehensions as to the simplified Nomenclature of Anatomy, 566; Two Corrections, 655
- Willcox, M. A., The Making of Solutions, 455
- Williams, Talcott, The Primitive Savage, 37
- WILLIAMS, HENRY S., Stratigraphical Geology, J. E. Marr, 547
- WILLIS, BAILEY, Geological Survey of Maryland, 252
- WILLISTON, S. W., Science and Politics, 114; Red-Beds of Kansas, 221
- WILLSON, FRED'K N., The Elements of Graphic Statics, 515
- Wisconsin Academy of Sciences, A. S. FLINT, 179
- WOOD, R. W., The Diffraction Process of Color Photography, 859
- WOODMAN, DURAND, The American Chemical Society, 58; N. Y. Section of the American Chemical Society, 258, 487, 654, 820, 913
- WOODS, ALBERT F., Die chemische Energie der lebenden Zellen, Oscar Loew, 409; Brunissure of the Vine and other Plants, 508
- WOODWARD, R. S., National Observatory, 470
- WOODWORTH, J. B., Kalendar für Geologen, K. Keilhack, 174
- WORTMAN, J. L., Othniel Charles Marsh, 561
- Wortman, Dr., H. F. O., 755
- YOUNG, C. A., National Observatory, 468
- Zone Temperatures, C. HART MERRIAM, 116
- Zoological, Notes, F. A. L., 73; H. C. B., 73, 156, 266, 459; Bibliography, F. A. BATHER, 154; Club, University of Chicago, MARY M. STURGES, 183; R. S. LILLIE, 183; MICHAEL F. GUYER, 876; Station at Naples, 596
- Zoo'logy, Methods of Teaching, EDWIN G. CONKLIN, 81

SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; J. LE CONTE, Geology; W. M. DAVIS, Physiography; O. C. MARSH, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; HENRY F. OSBORN, General Biology; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; J. McKEEN CATTELL, Psychology; DANIEL G. BRINTON, J. W. POWELL, Anthropology.

FRIDAY, JANUARY 6, 1899.

CONTENTS:

<i>The United States Naval Observatory:</i> PROFESSOR A. N. SKINNER.....	1
<i>The Psychology of Society:</i> PROFESSOR FRANKLIN H. GIDDINGS.....	16
<i>Atomic Weights:</i> DR. FERDINAND G. WIECHMANN	23
<i>John Cammings:</i> PROFESSOR WM. H. NILES.....	24
<i>Scientific Books:—</i>	
<i>Holman on Matter, Energy, Force and Work:</i> T. C. M. CONGDON'S <i>Qualitative Analysis;</i> <i>Muter's Manual of Analytical Chemistry:</i> PROFESSOR W. A. NOYES. <i>Thompson's Wild Animals I have known:</i> T. S. P. MORRIS'S <i>Human Anatomy:</i> PROFESSOR THOMAS DWIGHT. <i>General</i>	24
<i>Scientific Journals and Articles:</i>	29
<i>Societies and Academies:—</i>	
<i>The Nebraska Academy of Sciences; Science Club of Northwestern University:</i> PROFESSOR W. A. LOCY. <i>The Chemical Society of Washington:</i> WILLIAM A. KRUG. <i>Students' Geological Club and Conference of Harvard University:</i> J. M. BOUTWELL. <i>Torrey Botanical Club:</i> E. S. BURGESS	29
<i>Discussion and Correspondence:—</i>	
<i>The Pumas of the Western United States:</i> WITMER STONE. <i>The Schmidt-Dickert Moon Model:</i> OLIVER C. FARRINGTON. <i>Lehmann and Hansen on 'the Telepathic Problem':</i> PROFESSOR E. B. TITCHENER	34
<i>Astronomical Notes:—</i>	
<i>The November Meteors; Chase's Comet (J. 1898); Stellar Motions:</i> PROFESSOR WINSLOW UPTON....	36
<i>Current Notes on Anthropology:—</i>	
<i>The American Hero-Myth; The Primitive Savage; A Booklet on Ethnology:</i> PROFESSOR D. G. BRINTON	37
<i>Scientific Notes and News</i>	38
<i>University and Educational News</i>	40

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

THE UNITED STATES NAVAL OBSERVATORY.

ALTHOUGH much interest was shown by individuals in the science of astronomy in the early history of our country, this interest did not culminate in the founding of any astronomical observatories until the third and fourth decades of the present century. About 1835 Professors Olmsted and Loomis observed Halley's comet with a five-inch telescope placed in the steeple of one of the buildings of Yale College at New Haven, Connecticut, but the observatory erected by Professor Albert Hopkins of Williams College, in 1836, was probably the earliest establishment of the kind in the United States. It was 48 feet long by 20 in breadth, and consisted of a central apartment surmounted by a revolving dome and flanked by two wings. The dome contained an equatorially mounted Herschelien telescope of 10-feet focus, and a 3.5-inch transit instrument was set up in one of the wings. Only two years later Professor Loomis built a small observatory at Hudson, Ohio, and furnished it with a 4-inch equatorial telescope and a 2.7-inch transit circle. The longitude and latitude of this observatory was determined by Professor Loomis, and he observed five comets and sixteen occultations in the brief intervals of leisure left from his regular class work in the Western Reserve College. Another indication of the zeal of individuals in the advancement of science by actual astro-

nomical observation is shown by a paper published in the 'Transactions' of the American Philosophical Society, New Series, Vol. VII., pp. 165-213, detailing observations of nebulae made by H. L. Smith and E. P. Mason at New Haven, Connecticut, with a 12-inch reflector. This memoir contains carefully executed plates of several nebulae, on which the stars are accurately plotted.

Among those in our country who repeatedly urged the foundation of an astronomical observatory in the United States was John Quincy Adams. While Secretary of State, as early as 1823, he offered personally to contribute \$1,000 towards the establishment of an astronomical observatory in connection with Harvard College, provided the requisite amount for completing the work should be raised within two years, but this effort failed. In 1825, in his first message to Congress after becoming President of the United States, he made recommendations for the establishment of a national observatory, a uniform standard of weights and measures, a naval academy, a nautical almanac and a national university. Party rancor prevented the carrying-out of any of these far-reaching plans at that time, but all of them, except that of a national university, were executed by our government at a later date. It was some years after this notable message of President Adams before Emperor Nicholas, of Russia, entered upon the preliminary steps which culminated in the creation of the celebrated Pulkowa Observatory.

Even after leaving the Presidential chair, President Adams never once relaxed his efforts towards the founding of a national observatory. In 1838 our Minister to England announced that he had received the money bequeathed to the American people by James Smithson for the increase and diffusion of knowledge among men. Mr. Adams immediately urged that this fund should be devoted to the founding of an

astronomical observatory and a nautical almanac, and, as chairman of the select committee on the Smithson fund, he advocated that plan on three different occasions between 1838 and 1842. It is interesting to note that Senator Preston, of South Carolina, violently opposed these recommendations of Mr. Adams, but that in 1842 Mr. Preston gave the weight of his influence in favor of the bill which finally created a national observatory under the name of 'A Depot of Charts and Instruments of the Navy of the United States.' Let us trace the circumstances leading up to this event.

In 1830, under orders from the Navy Department, Lieutenant Goldsborough established a depot of charts and instruments in the western part of the City of Washington, in the square bounded by 24th and 25th Streets, Pennsylvania Avenue and K Street Northwest. Here, in a small circular building, on a brick pier with a foundation 20 feet below the surface, he mounted a 30-inch transit instrument made by R. Patten, of New York City. Goldsborough was succeeded in 1833 by Lieutenant Wilkes, who removed the depot to a site on Capitol Hill, on the west side of North Capitol Street, between B and C Streets north, about 1,200 feet, north, 5° west, from the center of the Capitol. The dimensions of the small observatory erected by Lieutenant Wilkes were 14 feet by 13 feet, and 10 feet from the floor to the eaves, and its outfit was as follows: A transit instrument of 3½ inches' aperture and 63 inches' focal length, made by Troughton under Hassler's direction for the U. S. Coast Survey in 1815, which was loaned to the Navy Department and mounted on massive piers. A Borda's circle presented by Troughton to Mr. Hassler in 1815; a 3½-foot achromatic portable telescope by Jones; a portable transit instrument made by Richard Patten, and a sidereal clock. The Patten transit instrument had previously been

mounted by Lieutenant Goldsborough in the depot of charts and instruments established by him, and was now mounted near the south door of the observatory for the use of the assistants. The sidereal clock was bolted to the western pier of the Troughton transit instrument, but it never performed satisfactorily.

On assuming command of the United States Exploring Expedition, in 1838, Lieutenant Wilkes turned over the direction of this observatory to Lieutenant J. M. Gilliss. To perfect and complete the instrumental outfit Gilliss was permitted by the Navy Department to order the following instruments: From Parkinson and Frodsham, of London, a sidereal clock and a meantime clock; from Ertel and Son, of Munich, a meridian circle of 4.5 inches' aperture, furnished with circles 30 inches' in diameter, one of which was graduated to three minutes; from William Simms a portable achromatic telescope of $3\frac{1}{2}$ inches' aperture and 42 inches' focal length. On the parapet of the Capitol building a south meridian mark was made, which was viewed by reducing the aperture of the transit instrument to 0.9 inch, and at a distance of 2,302 yards a north mark was erected, which could be viewed with the full aperture of the transit instrument. The north mark consisted of an obelisk of sandstone 18 feet high and 14 inches square at the top, having painted on its south face five black lines, three inches apart.

Up to 1838 the work at the 'Depot of Charts and Instruments' consisted of such astronomical observations as were needed for the rating of chronometers. In the beginning of that year instructions, prepared by Lieutenant Charles Wilkes, were transmitted through the Navy Department to Lieutenant Gilliss, directing him to cooperate with the United States Exploring Expedition during the years 1838 to 1842 by systematically observing the following

named objects: (1) The Moon and moon-culminating stars. (2) Falling stars, particularly the periodic ones in November. (3) All eclipses of the Sun and Moon. (4) Eclipses of Jupiter's satellites. (5) Occultations of the larger stars. In addition to the work required by these instructions Lieutenant Gilliss determined the right ascensions of 1,248 stars, which were reduced to the epoch January 1, 1840, compared with the right ascensions of the British Association Catalogue and published in 1846 in an 8vo. volume of astronomical observations containing xxv+671 pages. During the years 1840 to 1842 Gilliss also made at the 'Depot of Charts and Instruments,' a fine series of magnetic observations, which were published in 1845 in an 8vo. volume of xxviii+648 pages.

The facilities for scientific work at the little observatory on Capitol Hill were very limited, but Gilliss used them most assiduously. He endeavored by actual achievement to demonstrate to the Navy Department and to Congress the desirability of providing an observatory especially equipped for executing the most refined astronomical work, and in this he was successful. On the 15th of March, 1842, the House Committee on Naval Affairs reported to the House of Representatives a bill 'to authorize the construction of a Depot for Charts and Instruments of the Navy of the United States,' together with a written report which stated at some length that the present 'Depot' and its observatory are inadequate for the purposes intended, and are unsafe for the protection of the valuable instruments; that we are indebted to other nations for the data which enable our vessels to cross the ocean; that an observatory is absolutely essential to the performance of the duties which devolve upon the 'Depot;' that the existing observatory was erected at private expense, and that facilities should be provided for the execution of magnetic

observations. The wording of the bill which accompanied the report and became a law August 31, 1842, was as follows:

"Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled: That the Secretary of the Navy be and he is hereby authorized to contract for the building of a suitable house for a depot of charts and instruments of the Navy of the United States on a plan not exceeding in cost the sum of twenty-five thousand dollars.

"And be it further enacted: That the sum of ten thousand dollars be and is hereby appropriated of any money in the Treasury not otherwise appropriated towards carrying this law into effect.

"And be it further enacted: That the said establishment may be located on any portion of the public land in the District of Columbia which the President of the United States may deem suited to the purpose."

The Secretary of the Navy immediately placed the preparation of the plans for the new observatory in the hands of Lieutenant Gilliss, who, after consulting with astronomers in America, visited Europe to obtain the views of those competent to advise in these matters. In March, 1843, he returned home, having ordered the instruments under authority from the Secretary of the Navy. Only eighteen months were consumed in the erection of the buildings, the mounting of the instruments and the procuring of a library, and on the 7th of February, 1845, Gilliss presented a detailed report of his labors (Senate Document, No. 114, 28th Congress, 2d session, Vol. VII.) which contains a careful description of the buildings and instruments, illustrated by accurate drawings. The site selected for the building was a reservation between 23d and 25th Streets west, extending from E Street north to the Potomac river. The area of the plot was 17.85 acres. The elevation of the ground on the building site was about 100 feet above the Potomac. Gilliss stated that the new equipment was as follows: 1st, an achromatic equatorial telescope by Merz and Mahler, Munich, of 9.6 inches' aperture. 2d, a meridian transit instrument of 5½

inches' aperture by Ertel, of Munich. 3d, a prime vertical transit instrument of 4.9 inches' aperture by Pistor and Martins, Berlin. 4th, a mural circle by Troughton and Simms, London, with a telescope of 4.1 inches' aperture, and a circle 5 feet in diameter divided to 5' and read by six micrometer microscopes. 5th, a comet seeker of 4 inches' aperture by Utzschneider and Fraunhofer, Munich. 6th, magnetic instruments. 7th, meteorological instruments. 8th, books. In addition to those items purchased, there belonged to the 'Depot of Charts and Instruments' a portable transit and two clocks, purchased by Lieutenant Wilkes for the Exploring Expedition, and a 30-inch transit circle and two clocks ordered by Gilliss for the 'Depot.'

At the close of September, 1844, Gilliss reported the observatory completed, with the instruments mounted and ready for use. On the 1st of October, 1844, Lieutenant M. F. Maury was ordered to take charge of the institution, and directed to remove to it all the nautical books, charts and instruments of the then-existing depot.

In reviewing the history of the Naval Observatory during Maury's administration, we shall first notice the instrumental equipment, in the selection of which it is probable that Gilliss was principally influenced by English advisers. Instrumental construction was just then passing through a critical period. The Observatory of Pulkowa, which was completed in 1838, following the German school of construction, rejected the mural circle, and supplied its place with the celebrated Ertel vertical circle. An Ertel transit instrument and a Repsold meridian circle completed the outfit of Pulkowa for meridian work, and these instruments were amply provided with horizontal collimators and azimuth marks distant 550 feet, which were rendered visible by the interposition of lenses of corresponding focal length. In contrast with this, the Naval

Observatory followed English precedent, and was supplied with a mural circle which remained its principal declination instrument until 1865. The remaining equipment was the Ertel transit instrument, of first-class construction, but without horizontal collimators and azimuth marks; the small Ertel meridian circle, which had been ordered by Gilliss for the Observatory on Capitol Hill; the Pistor and Martins prime-vertical transit instrument, identical in design with the similar instrument at Pulkowa; and the Merz and Mahler equatorial refracting telescope. The Ertel meridian circle showed such serious defects of construction that it was subsequently sold, and the Merz and Mahler equatorial was much smaller than the refractors at Pulkowa and Harvard College Observatories, one of which was erected a little before and the other a little after that at the Naval Observatory. It may also be mentioned that instead of making the walls of its observing rooms of brick, the Naval Observatory might advantageously have followed the example of Pulkowa by making them of wood, the use of sheet metal for such purposes being then unknown.

Now, for a passing glance at the personnel of the astronomical corps, which was composed of three more or less distinct classes, namely, line officers and staff officers of the United States Navy and civilians. After years of persistent labor, Gilliss had created an astronomical observatory only to have it snatched from his grasp when it was ready for work. Lieutenant Matthew F. Maury, who was ordered to take charge of the new 'Depot of Charts and Instruments' as its Superintendent on October 1, 1844, was then thirty-eight years old. He was possessed of great energy, together with a high degree of native ability, and was well versed in naval affairs, but was very scantily informed in regard to the great advances in astronomical science

which had recently been made in Europe. From the line of the navy three lieutenants and six midshipmen were detailed as his assistants. These gentlemen entered upon their work with energy, but their tour of duty was so limited by the rules of the Navy Department that they were obliged to return to their nautical work when they had barely familiarized themselves with their astronomical duties. Among their names will be recognized many who at a later date attained distinction during the Civil War. To these line officers were added Professors of Mathematics Coffin, Keith and Hubbard, who were staff officers in the Navy. The corps of Professors of Mathematics in the United States Navy was originally created to supply instructors for midshipmen afloat and ashore, and all of them served in that capacity, until the founding of the Naval Academy in 1845 closed their seafaring career and gave the Navy Department an opportunity to utilize a part of the corps in other duties. Professor Coffin had instructed midshipmen on shipboard for some half dozen years before he was ordered to assist Lieutenant Gilliss in 1843 in fitting up the new Observatory. Hubbard, a recent graduate of Yale College, was appointed Professor of Mathematics, U. S. N., in 1845, and was immediately ordered to the Observatory. Keith, who had just graduated from Middlebury College, Vt., received his appointment as Professor of Mathematics, U. S. N., in 1847. These gentlemen were each possessed of a high degree of mathematical ability and were destined to leave a lasting impress on the work of the Observatory. At that time the only civil appointee attached to the Observatory was Mr. Sears Cook Walker, who was employed as a computer and observer. He was one of the ablest, and certainly the most experienced, of the corps of astronomers, but unfortunate differences with

Lieutenant Maury led to his resignation after a service of only fourteen months. In 1848 Mr. James Ferguson received the civilian appointment of Assistant Observer, and later that of Assistant Astronomer. He proved an indefatigable observer, and the records of the Observatory show a vast amount of valuable and painstaking work with the equatorial by him. In 1851 Professor Yarnall, U.S.N., was ordered to the Observatory, and in the most untiring and conscientious manner he made substantially all the observations obtained with the mural circle and the Ertel transit instrument during the decade from 1850 to 1860. Professor Keith withdrew from the Observatory in 1853, and Professor Coffin was obliged to give up astronomical observing in 1850 on account of an affection of his eyes.

The work of the Observatory as published during Maury's administration is contained in the following volumes: The Observations for 1845, published in 1846; the Observations for 1846, published in 1851; the observations for 1847, published in 1853; the observations for 1848, published in 1856; the observations for 1849-1850 (one volume), published in 1859. It is worth noting that in the published volumes from 1845 to 1848 inclusive the institution is designated as the National Observatory, but on December 12, 1854, the Hon. J. C. Dobbins, Secretary of the Navy, directed that its official designation should be 'The United States Naval Observatory and Hydrographical Office,' and accordingly all subsequent volumes have been issued as the work of the United States Naval Observatory.

The scheme of work arranged by Maury was as follows: To observe regularly in the meridian the positions of the Sun, Moon, planets and moon-culminating stars; to observe α Lyræ regularly with the prime vertical transit, to determine with that instrument the declinations of a catalogue of zenith stars, and to review the Dorpat

Catalogue of double stars with the equatorial telescope.

The meridian observations of the Sun, Moon and planets were commenced in 1845 with some degree of ardor, and kept up with decreasing persistency for several years, but after 1850 only a few scattering observations occur in the published records. The prime vertical transit was also employed for a few years, but soon after 1850 it fell into disuse.

The equatorial was used continuously during the entire period from 1845 to 1861. Assistant Astronomer Ferguson had charge of it during a large portion of this time, and the records show an unbroken series of carefully executed observations of comets, minor planets and occultations of stars by the Moon. The assiduity of Ferguson is attested by his discovery of three minor planets, viz: Euphrosyne, No. 31, on September 1, 1854; Virginia, No. 50, on October 4, 1857; Echo, No. 60, on September 14, 1860.

It would be an act of injustice to pass by unmentioned the numerous items of personal work which enrich the published records. In them we find Coffin's refraction tables founded on Bessel; tables for aiding in the reduction of the apparent places of stars to mean places, by Coffin, Keith and Hubbard; an investigation of the latitude of the observatory and a discussion of the errors of standard thermometers, by S. C. Walker; and last, but not least, we must mention S. C. Walker's discovery, on February 4, 1847, that certain stars observed by Lalande at Paris on May 8 and 10, 1795, were the recently discovered planet Neptune; thus extending the observations of that planet over an interval of fifty years, and thereby making the determination of its elements much more precise.

By far the most ambitious task which Maury set for the new observatory was detailed in his letter to George Bancroft, Sec-

retary of the Navy, July 28, 1846. Speaking of the regular work upon the Sun, Moon and planets, he adds: "A regular series of observations is continued on these objects and the time which is not occupied in the round with them has, with your approval, been devoted to cataloguing; to this end a regular and systematic exploration of the whole heavens from 45° south has been commenced, with the intention of penetrating with the telescope every point of space from that parallel of declination up to the north pole, and of assigning position to every star, down to the 10th magnitude, that shall pass through the field of view." The amount of labor involved in this colossal undertaking was entirely beyond the capacity of any one observatory to accomplish in a generation. Maury would never have undertaken it if he had possessed an intimate knowledge of the herculean labor in respect to observation and computation which its execution demanded. The result was that the observation of the zones was continued with some degree of energy through the years 1846, '47, '48 and '49 with the transit instrument, the mural circle and the meridian circle, by some eleven different observers, two of whom were experienced, and the remainder quite inexperienced. The number of observations accumulated un-reduced in these four years was fully 38,000. Maury did not publish any results until 1860, when he issued the meridian circle zones observed in 1846, containing about 4,000 observations. The publication of the remaining zone work was delayed until 1873, when it was printed under the supervision of Professor Asaph Hall, who remarks: "On account of the inexperience of some of the observers and the lack of good organization these observations contain many errors, and the whole work needs a careful revision." To furnish material for this revision, four hundred and fifteen zero stars were selected by Professor Hall from

the zones, and their places have since been determined, but as yet the revision has not been accomplished. In contrast with this we may recall that during the decade 1850 to 1860 Argelander, of the Bonn Observatory, in accordance with a carefully conceived plan, observed and published the approximate positions of more than 450,000 stars of the first nine magnitudes between 23° of south declination and the north pole of the heavens. Maury failed because his scheme was entirely too herculean to be accomplished with the means at his command, while Argelander achieved success by bringing the scope and precision of his work within the limits possible of execution.

A review of this period would be incomplete without a reference to the invention of the chronographic method of registering star transits and the general application of electro-magnetism to the transmission of time signals for the determination of differences of longitude. Soon after the invention of the telegraph several persons at about the same time conceived the idea of applying its fundamental principles to the transmission of clock signals and the registering of star transits. Among them were Walker, Bache, Bond, Mitchell, Saxton and Locke. Lieutenant Maury became interested in the labors of the last-named gentleman, and induced Congress to appropriate \$10,000 on March 3, 1849, to pay Dr. Locke, of Cincinnati, for the construction and use at the National Observatory of a magnetic clock, a fillet chronograph and a cylinder chronograph. These instruments, although not perfect in details, embraced the essential features of the chronographs in actual use at the present time.

We come now to the third period of the history of the Observatory—namely, from Maury's resignation to the removal to the new site. On April 20, 1861, Maury suddenly resigned his commission and went south to join the Rebellion, and on April

23 Commander J. M. Gilliss, who had built the Observatory some sixteen years before, was ordered to assume charge. For ten years previous to his withdrawal Maury had ceased to have an active interest in astronomical work, and had been wholly absorbed in hydrographic studies. Upon the accession of Gilliss new life was immediately infused into the institution. He resumed meridian observations of the Sun, Moon and planets, which had been practically suspended, and made it one of his first tasks to press the completion of all the unfinished work, which had been accumulating since 1852. At the same time he carried on with equal zeal the nautical work of the Observatory, which the Civil War, then just beginning, had very largely increased.

Until June 21, 1866, when the Hydrographic Office was created, an important part of the duties of the Naval Observatory had been to care for and issue to the Navy all charts, sailing directions, compasses, chronometers, sextants, spy-glasses and other nautical instruments. At the date above mentioned the care of all this material, except chronometers, was transferred from the Observatory, but most of it was returned in 1883, and since then the Observatory has had charge of all nautical instruments of the Navy, except charts and compasses. Since January 1, 1884, all chronometers have been regularly subjected to a temperature test ranging from 45° to 95° Fahrenheit.

During the Civil War, from 1861 to 1865, the duties devolving on the Observatory, in connection with the inspection and issue of all varieties of nautical instruments, were especially arduous, and the constant attention of a number of officers was required to supply each of our several hundred war vessels with their needed outfits.

Since August, 1865, in accordance with a plan originated by Professor Harkness, the Naval Observatory has transmitted time

signals daily, except Sundays and holidays, over the telegraph lines running into the chronometer room. Up to the latter part of the year 1879 these signals were transmitted by hand, but since that date they have been sent by an automatic apparatus in connection with the transmitting clock devised by Professor J. R. Eastman. Time balls in a large number of the principal cities of the country are dropped by them.

In 1862 Congress authorized the appointment of three civilians, called aids, to assist in meeting the increased demands on the Observatory on account of the war. Some of the changes in the personnel during this period were as follows:

Simon Newcomb was appointed Professor of Mathematics, U. S. N., in 1861; Asaph Hall, William Harkness and J. R. Eastman received appointments as aids in 1862. Hall and Harkness were promoted in 1863, and Eastman in 1865, to be Professors of Mathematics, U. S. N. In 1863 the Observatory lost by death the gifted Professor Hubbard, whose labors had been restricted for years by a frail body.

The later additions to the personnel were as follows: Edgar Frisby was appointed Assistant Astronomer in 1868; A. N. Skinner in 1870 and H. M. Paul in 1875. Frisby was promoted to be Professor of Mathematics, U. S. N., in 1878, on the retirement of Professor Yarnall.

Soon after Gilliss' accession to the superintendency it became apparent that in order to meet the demands of science the Observatory needed a first-class meridian circle, and he took steps to remedy this defect in its equipment. The result was the sale of the small Ertel meridian circle, and the mounting in 1865 of a Pistor and Martins meridian circle 8.52 inches' aperture. The Ertel transit instrument was moved to the east wing and the new meridian circle took its place in the west wing.

In 1873 the Observatory received the

great 26-inch equatorial refractor by Alvan Clark & Sons, which was then the largest telescope in the world.

A continuous series of Sun, Moon and planet meridian observations was carried on from 1861 to 1865 with the mural circle and the transit instrument. In the beginning of 1866 the new Pistor and Martins meridian circle was put in service, and observations were made with it in the old west transit room until 1869, June 5. It was then removed to the new transit room, where it was used from February 2 to August 15, 1870, when observations were suspended for some repairs on the instrument. They were resumed in 1871, August 1, and then continued until 1891, June 28, when the instrument was dismantled for removal to the new Observatory. In connection with the Sun, Moon and planet observations, there were made on this instrument extensive determinations of the positions of the Ephemeris stars and of large numbers of miscellaneous stars. When the mural circle and transit instrument were relieved of the planet work, Professor Yarnall devoted them to the completion of the determination of the positions of all miscellaneous stars which had been observed with them since 1845. These collected observations form Yarnall's catalogue, which was published later. The equatorials were assiduously employed on the observation of asteroids, comets, occultations, double stars, satellites, and other work for which they were especially adapted.

The annual volumes of observations were published regularly from 1861 to 1890, and the principal memoirs and researches of greater or less extent appearing in them during this period are as follows:

The solar parallax; from equatorial observations of Mars, 8.8415'' by Professor Hall, Washington Observatory 1863, p. XI; from meridian observations of Mars, 8.8310'' by Assistant Astronomer Ferguson, Washington Observations, 1863, p. XI.

Discussion of the solar parallax by all known methods, 8.848'' by Professor Newcomb, Washington Observations, 1865, App. II.

A catalogue of the positions of 151 stars in *Præsepe* by Professor Hall, Washington Observations, 1867, App. IV.

Reports on the solar eclipse of 1869, August 7; Washington Observations, 1867, App. I.

Reports on the solar eclipse of 1870, December 22; Washington Observations, 1869, App. I.

Reports on the solar eclipse of 1873, July 29; Washington Observations, 1876, App. III.

Reports on the solar eclipses of 1880, January 11; Washington Observations, 1876, App. III.

The following embrace all of Hall's double-star work with the 26-inch equatorial; Washington Observations, 1876, App. IV., and Washington Observations, 1888, App. I.

The time of rotation of Saturn on its axis was determined by Professor Hall by means of an equatorial spot which was visible from 1876, December 7, to 1877, January 2. The period deduced was $10^h 14^m 23.8^s$ mean solar time. The paper may be found in the *Astronomische Nachrichten* No. 2146.

On the right ascensions of the equatorial fundamental stars, by Professor Newcomb, Washington Observations, 1870, App. III.

Researches on the motion of the Moon, by Professor Newcomb, Washington Observations, 1875, App. II.

The Uranian and Neptunian systems, Professor Newcomb, Washington Observations, 1873, App. I.

The central parts of the nebula of Orion, Professor Holden, Washington Observations, 1878, App. I.

A catalogue of 10,964 stars from observations on the mural circle and transit instrument, by Professor Yarnall, revised edition by Professor Frisby, Washington Observations, 1884, App. I.

A catalogue of 1963 stars observed by Gilliss, at Santiago, Chili, edited by Professor Harkness, 1868, App. I.

Observations and orbits of the satellites of Mars, Washington 1878. This memoir is bound with some copies of Washington Observations, 1875.

The two satellites of Mars were discovered by Professor Hall in August, 1877, with the 26-inch equatorial.

The six inner satellites of Saturn, by Professor Hall, Washington Observations, 1883, App. I.

Saturn and its rings, by Professor Hall, Washington Observations, 1885, App. I.

Observations for stellar parallax, by Professor Hall, Washington Observations, 1883, App. II.

The solar parallax and its related constants, by Professor Harkness, Washington Observations, 1885, App. III.

Reports on the observations of Encke's comet during its return in 1871, by Professors Hall and Harkness, Washington Observations, 1870, App. II.

Chronometer rates as effected by changes of temperature and other causes, by Commander C. H. Davis, Jr., Washington Observations, 1875, App. III.

The following differences of Longitude have been determined between Washington and

Havana, Cuba, Professor Harkness, Washington Observations, 1867, App. I.

St. Louis, Professor Harkness, Washington Observations, 1870, App. I.

Detroit, Mich. } Professor Eastman, Washington
Carlin, Nev. } Observations, 1872, App. II.
Austin, Nev. }

Ogden, Utah, Professor Eastman, Washington Observations, 1874, App. II.

Sayre Observatory, South Bethlehem, Pa.; Professor Eastman, Washington Observations, 1875, App. I.

Cincinnati Observatory, Professor Eastman; Washington Observations, 1876, App. IV.

Morrison Observatory, Glasgow, Mo.; Professor Eastman, Washington Observations, 1876, App. V.

Observatory Princeton, N. J.; Assistant Astronomer Paul, Washington Observations, 1878, App. II.

The zone observations made in 1846-1849 were published as follows:

Meridian circle zones observed in 1846 (a separate publication) contains 4,054 stars, 1860.

Mural circle zones 14,804 stars, Washington Observations, 1869, App. II.

Transit zones, 12,033 stars, Washington Observations, 1870, App. IV.

Meridian circle zones observed in 1847, '48, '49, 7,390 stars, Washington Observations, 1871, App. I.

Results of observations made with the transit instrument and mural circle, 1853 to 1860 inclusive, Washington Observations, 1871, App. II.

Report of Lieut. A. G. Winterhalter as delegate of the United States Naval Observatory to the Astrophotographic Congress held in Paris 1887; with a report on European observatories, Washington Observations, 1885, App. I.

Announcement of the discovery in April 1888, and the subsequent determination of the elements, of a new short-period variable star, S Antilæ = No. 3407 of Chandler's catalogue; by Assistant Astronomer H. M. Paul, *Astronomical Journal* No. 215.

A magnetic observatory was arranged by Maury in 1845, but its construction was so faulty and inadequate that its use was soon discontinued. Nothing further was done

in reference to magnetic observations until 1887, when the Bureau of Navigation erected on the grounds of the Naval Observatory a complete magnetic outfit which was provided with facilities for obtaining continuous photographic records of declination, inclination and horizontal force. Instruments were also provided for the necessary absolute determinations of the magnetic elements. This magnetic outfit was turned over to the Observatory in July, 1887. Observations were commenced soon after that date, and continued until September, 1892, when the instruments were removed to the new site.

The preparations for the observations of the transits of Venus of 1874 and 1882, by the United States Transit of Venus Commission, were made at the Naval Observatory as the headquarters of the operations of the Commission, but although this work was done principally by Professors Newcomb and Harkness, it was entirely distinct from the work of the Observatory.

During the years 1885, 1886 and 1887 Professor S. J. Brown, U. S. N., was permitted by courtesy of the Superintendent of the Naval Academy to use its 4-inch Repsold meridian circle as an adjunct of the Naval Observatory in making a series of determinations of the positions of the 303 stars which had been selected to serve as the basis of the German Astronomical Society's southern zones.

When it became known that the work of the Naval Observatory would be interrupted by its removal to a new site the trustees of the Washburn Observatory, of Madison, Wis., very considerably offered the free use of the instruments of the Washburn Observatory to the staff of the Naval Observatory during that period. In acceptance of this invitation Professor S. J. Brown went to Madison on the conclusion of his Annapolis work, and from October, 1887, to October, 1890, conducted a series of

observations with the 4.8-inch Repsold meridian circle on the 'zusatz' stars Nos. 337 to 539 of the Berlin Jahrbuch.

Principally through the exertions of Rear Admiral John Rodgers, during his superintendency, Congress purchased a new site for the Naval Observatory on Georgetown Heights in 1881. Appropriations for the construction of new buildings on this site were made by Congress in 1886, plans for them were prepared by the celebrated New York architect, R. M. Hunt, and in the beginning of 1893 they were sufficiently complete to warrant the transfer of the establishment to the new site.

We come now to the fourth period in the history of the Observatory, namely, from its change of location to the present time.

The new site is distant about two miles in a northwesterly direction from the old Observatory, and occupies 69.78 acres on Georgetown Heights, the buildings being situated on ground elevated from 260 to 280 feet above the Potomac River. The shape of the tract is so irregular that its reentrant angles occasionally approach the buildings more closely than is desirable, and, to remedy this, Congress has enacted a law authorizing the laying out of a circle having a radius of one thousand feet about the center of the clock room, and the acquiring for the Observatory of all the land included therein which is not now owned by the government. This consists principally of two tracts, one of 1.70 acres and the other of 7.87 acres, and the area included in the proposed circle will closely equal that of the original irregular tract. The plans adopted for the new Observatory involved the erection of one building principally for offices, and a separate cluster of isolated buildings for the principal instruments. The main building has the library on its eastern end, and a tower for the smaller equatorial on its western end, with an adjoining meridian room still further west. About 410 feet

northwest of the center of the main building is the clock room, which occupies the center of the cluster of instrument buildings. It is flanked on the east and on the west by connecting observers' rooms, which the observers occupy in the intervals between observations; the chronographs being installed therein, and the rooms being heated by steam. Twenty-five feet to the east of the east observers' room is the entirely isolated East Transit House, and at the same distance west of the west observers' room is the similarly isolated West Transit House.

Fifty feet to the north of the center of the clock room is the entirely isolated Prime Vertical Transit House; and 175 feet to the south of the clock room is the dome of the 26-inch equatorial, with two connecting rooms for the use of the astronomer in charge. About 275 feet northwest of the center of the clock room is a circular wooden building 11.5 feet in diameter, surmounted by a revolving dome, for the alt-azimuth instrument. Four hundred feet to the southeast of the clock room is mounted the horizontal photoheliograph, and 250 feet south of this is the magnetic observatory. Six hundred and fifty feet north of the main building is the Superintendent's residence, and 250 feet southeast of the library are quarters occupied respectively by the professors of mathematics in charge of the 26-inch equatorial and the 9-inch meridian circle. About 200 feet northeast of the library is the boiler house, where steam is generated for heating most of the buildings on the grounds. The main building and the 26-inch equatorial building are constructed of white marble, but the four transit houses are built entirely of metal, having iron frames, with double walls and roofs of corrugated metallic plates, which have proved very effective in preserving an equality between the outside and inside temperatures. The carefully constructed

foundations for supporting the piers of the instruments are unusually massive and give unsurpassed stability. All the revolving domes and the shutter machinery of the transit houses were made by Warner and Swasey, of Cleveland, Ohio, and operate in the most satisfactory manner.

Passing now to the instrumental equipment, the 9.6-inch equatorial refractor is replaced by a telescope having a 12-inch object-glass made by Clark and equatorially mounted by Saegmüller. This instrument occupies a 26-foot dome on the tower at the west end of the main building. The 26-inch equatorial is provided with a new mounting by Warner and Swasey, and a powerful spectroscope by Brashear. Its dome is forty-five feet in diameter, and is provided with an hydraulic elevating floor having a range of motion of twelve feet. The Ertel transit instrument is remounted without change in the meridian room at the west end of the main building. The Pistor and Martins meridian circle has received the following modifications: The 8.5-inch object-glass of 12-feet focal length has been replaced by a 9.14-inch Clark object-glass of 107 inches focal length, and the tube has been shortened accordingly; the arms for supporting the microscopes have been replaced by a brass alidade, on the edge of which the microscopes may be clamped in any position; the old collimators of 2½ inches aperture have been replaced by new ones of 4 inches aperture, for which new mountings have been provided, and the apertures in the cube of the instrument have been correspondingly enlarged. The shortening of the telescope made it necessary to reduce the height of the piers, and new marble piers have been provided for the collimators. A vertical collimator has also been added, together with a north meridian mark erected at a distance of 380 feet, which is viewed by means of a lens of the same focal length, having an aperture of six inches,

and mounted on the north collimator pier immediately below the collimator.

Two new instruments have been provided which were designed solely by Professor William Harkness, and built by Warner and Swasey, viz.: 1. A meridian circle, constructed entirely of steel, which is mounted in the west transit house. The object-glass has a clear aperture of six inches, and the instrument has two circles each 26 inches in diameter and each graduated to two minutes. It is provided with two horizontal collimators 3.5 inches in aperture, a vertical collimator, and a north meridian mark distant 380 feet. The latter is viewed through a lens of corresponding focal length, which is mounted on the north collimator pier immediately below the collimator. 2. The other new instrument designed by Professor Harkness, and built by Warner and Swasey, is the alt-azimuth. This, like the new six-inch meridian circle, is constructed entirely of steel. The aperture of its object-glass is five inches, and the diameters of its vertical and horizontal circles are 26 inches, each being graduated to two minutes.

One of the Transit of Venus 40-foot horizontal photoheliographs is mounted with all its accessories in the location previously indicated, and to the south of it a well designed magnetic observatory has been built, as mentioned above.

From its inception until July 22, 1863, the Naval Observatory was under the Bureau of Ordnance and Hydrography; from July 22, 1863, to July 1, 1889, it was under the Bureau of Navigation; from July 1, 1889, to the present time, it has been under the Bureau of Equipment and Recruiting, whose name was changed July 1, 1890, to the Bureau of Equipment.

Before considering the present organization of the Naval Observatory it will be convenient to give the following list of those who have held the office of Superintendent:

Lieutenant, later Commander, M. F. Maury, October 1, 1844, to his resignation April 20, 1861.

Commander, later Captain, J. M. Gilliss, April 23, 1861, to his death February 9, 1865.

Rear Admiral C. H. Davis, April 28, 1865, to May 8, 1867.

Commodore, later Rear Admiral, B. F. Sands, May 8, 1867, to his retirement February 11, 1874.

Rear Admiral C. H. Davis, February 16, 1874, to his death, February 18, 1877.

Rear Admiral John Rodgers, May 1, 1877, to his death May 5, 1882.

Vice Admiral S. C. Rowan, July 1, 1882, to May 1, 1883.

Rear Admiral R. W. Shufeldt, May 1, 1883, to February 21, 1884.

Commodore S. R. Franklin, February 21, 1884, to March 31, 1885.

Commodore George E. Belknap, June 1, 1885, to June 7, 1886.

Captain R. L. Phythian, November 15, 1886, to June 28, 1890.

Captain F. V. McNair, June 28, 1890, to November 21, 1894.

Commodore R. L. Phythian, November 21, 1894, to July 19, 1897.

Commander, later Captain, C. H. Davis, from July 19, 1897, the present incumbent.

From its foundation until 1894 the Superintendent was the sole head of the Observatory. On March 3, 1847, Congress enacted that he must be either a captain, a commander or a lieutenant in the Navy, but on March 3, 1865, that restriction was repealed, and it was enacted that: "The officer of the Navy employed as Superintendent shall receive as salary only the shore-duty pay of his grade."

The work of the Observatory is distributed under the following Heads of Departments: The Astronomical Director, the Heads of the Departments of Nautical Instruments, of Chronometers and Time Service, and of Magnetism and Meteorology. The duties of these Heads of Departments are as follows:

The Astronomical Director. This office was created by an order of the Secretary of the Navy, September 20, 1894, which defined the duties of the incumbent as fol-

lows: The Astronomical Director has charge of and is responsible for the direction, scope, character, quantity and preparation for publication of all work purely astronomical which is performed at the Naval Observatory. He has charge of the 26-inch and 12-inch equatorial telescopes, the 6-inch and 9-inch transit circles, the prime-vertical instrument, the photoheliograph, and all other instruments and accessories used in his department, together with the construction, remounting and repairing of all astronomical instruments placed in his charge. He personally inspects, both day and night, the methods of observation and computation in all the astronomical departments.

The Head of the Department of Nautical Instruments sees that all nautical instruments issued from the Observatory, except chronometers, are thoroughly inspected and tested before issue.

The Head of the Department of Chronometers and Time Service has charge of the chronometers deposited at the Naval Observatory; he inspects, tests, rates and prepares them for issue; he has charge of the transmission of the daily time signals and the apparatus pertaining to them; finally he makes all necessary determinations of local time for use in his department, and for this purpose has the use of the 5-inch Ertel transit instrument, which is mounted in the meridian room at the west end of the main building.

The Head of the Department of Magnetism and Meteorology has charge of all the magnetic and meteorological apparatus and observations.

The Superintendent as commanding officer is charged with the general superintendence and government of the Observatory. The heads of departments, naval officers, assistant astronomers, computers and employes performing duty at the Observatory are subject to him, and he is responsible for the disbursement of all moneys

appropriated by Congress to sustain the Observatory.

The present personnel is as follows: Superintendent, Captain C. H. Davis, U. S. N.; Lieutenant A. N. Mayer, U. S. N., in charge of the chronometers and time service, and also general storekeeper and inspector of nautical instruments; Professor H. M. Paul, U. S. N., in charge of magnetic and meteorological observations; Computer M. E. Porter; Instrument-maker William F. Gardner.

The Astronomical Director is Professor William Harkness, U. S. N., and immediately under him are Professor Edgar Frisby, U. S. N., in charge of the 12-inch equatorial refractor; Professor S. J. Brown, U. S. N., in charge of the 26-inch equatorial refractor; Professor A. N. Skinner, U. S. N., in charge of the 9-inch meridian circle; Assistant Astronomer G. A. Hill, in charge of the prime-vertical transit and the alt-azimuth; Assistant Astronomers T. I. King and F. B. Littell; Computers E. A. Boeger, G. K. Lawton, William M. Brown and F. H. Parsons; Photographer George H. Peters.

The 6-inch transit circle is not yet ready for use.

The work of the Observatory since its removal to the new site, in the beginning of 1893, has been as follows:

In 1888 the management of the Naval Observatory acceded to a request from the German Astronomical Society to determine, in accordance with its general program, the positions of the stars in the zone $-13^{\circ} 50'$ to $-18^{\circ} 10'$ of declination. Various difficulties prevented the execution of this work at the old Observatory, but as soon as the 9-inch transit circle was got into working order at the new site the Superintendent, Captain F. V. McNair, directed Assistant Astronomer A. N. Skinner to proceed with the observations, and gave him the assistance of Computers T. I. King and F. B. Littell for that purpose. The

first zone was observed January 13, 1894, and with the exception of a few scattering stars, the entire work was completed in 182 zones, the last of which was observed on May 26, 1897. The program involved the determination of the position of 8,689 stars, with at least two observations of each. The number of observations actually made was 19,762, of which 18,062 were zone stars and 1,700 were zero stars. The reduction of these observations is about three-fourths completed. In the course of the zone observations Assistant Astronomer Skinner discovered the variability of the following stars:

X Hydræ, announced in the *Astronomical Journal*, No. 332.

W Ceti, announced in the *Astronomical Journal*, No. 342.

RT Libræ, announced in the *Astronomical Journal*, No. 352.

Z Capricorni, announced in the *Astronomical Journal*, No. 358.

The meridian observations of the Sun, Moon and planets were necessarily interrupted by the removal to the new site. As stated above, these observations were suspended June 29, 1891, and it was not found expedient to resume them until after the appointment of the Astronomical Director in September, 1894. During the progress of the observations of the German zone, other meridian observations could not be pushed energetically, and until the zone reductions are completed they will be limited to the Sun, Moon and planets, the necessary ephemeris stars, and a few miscellaneous stars. The Sun and major planets are now observed on the meridian every day, except Sundays and holidays, and the Moon is observed at every visible transit. The reductions of these observations are nearly completed to within a few months of date.

The 12-inch equatorial has been continuously employed by Professor Frisby on observations of asteroids, comets, occultations

of stars by the Moon, and eclipses of Jupiter's satellites. Much of the current work of this instrument may be found in the *Astronomical Journal*.

The 26-inch equatorial has been continuously employed by Professor Brown on observations of the more difficult asteroids, on double stars, and on the satellites of Mars, Saturn, Uranus and Neptune. In recent months some spectroscopic work has been done.

Assistant Astronomer George A. Hill has charge of the Prime Vertical transit instrument and the alt-azimuth. With the Prime Vertical transit from July 24, 1893, to November 20, 1898, he has made 1,140 observations of α Lyræ, θ Aurigæ, α Canum Venaticorum, μ Andromedæ and γ Bootis. With the alt-azimuth instrument from February 24, 1898, to November 20, 1898, he has made 425 vertical-circle observations of American Ephemeris stars, and from November 22, 1894, to November 20, 1898, he has also made 599 zenith telescope observations of pairs of stars selected in groups as suggested by Küstner.

As at the old Observatory, meteorological observations are taken every three hours by the watchman on duty. After removal to the new site magnetic observations were resumed, but it was soon found that the influence of the suburban electric roads in the vicinity entirely vitiated the photographic records, and they were discontinued in the summer of 1898.

The annual volume of Observations for the year 1889 was published in 1893, and that for 1890 was published in 1895. The latter contained an important appendix entitled 'A catalogue of 16,748 stars, deduced by the Naval Observatory from zone observations made at Santiago de Chili by the United States Naval Astronomical Expedition to the Southern Hemisphere during the years 1849, '50, '51, '52, Lieut. J. M. Gilliss, U.S.N., Superintendent.' Advantage

was taken of the interruption of the work of the Observatory by reason of its removal to a new site, to complete the reduction of these zone observations. Among the many persons who have shared in the computations Professors Harkness, Frisby and Brown have performed the most important part.

In November, 1898, was published Appendix I to the Washington Observations for 1892, entitled 'The Second Washington Catalogue of Stars, together with the annual results upon which it is based; the whole derived from observations made at the United States Naval Observatory with the 8.5-inch Transit Circle during the years 1866 to 1891 and reduced to the epoch 1875.0, prepared under the direction of John R. Eastman, Professor of Mathematics, U.S.N.' This catalogue contains the positions of 5,151 stars which have been derived from 72,941 observations, being the entire series made while the Pistor and Martins transit circle was located at the old Observatory.

It will be noted that the Naval Observatory owes its existence primarily to an attempt on the part of naval officers to provide a depot for the care and issue of charts and nautical instruments. This naturally involved the equipment of the Depot with such astronomical instruments as are necessary for rating chronometers, but the needs of the Wilkes Exploring Expedition of 1838 to 1842, and the inception of the American Ephemeris and Nautical Almanac ten years later, soon showed the necessity for an instrumental equipment sufficient to cope with all astronomical problems, and that followed in due time. The principal aim of the Naval Observatory has always been to carry forward a continuous series of Meridian observations on the Sun, Moon and planets, such as can only be undertaken by great government observatories, like those of Greenwich and Paris. Since 1861 this work

has been kept up assiduously, and in recent years the number of meridian observations of the Moon has largely surpassed those made anywhere else.

In spite of this limitation in the scope of its operations, the Naval Observatory has not been unmindful of other lines of work. As instances of this may be cited the brilliant discovery of the moons of Mars by Professor Hall; the extensive work upon the satellites of the outer planets by Professors Hall, Newcomb and Brown; and finally the star catalogues of Professors Yarnall and Eastman and the contribution to the great star catalogue of the German Astronomical Society in the observation of the zone of stars from $13^{\circ} 50'$ to $18^{\circ} 10'$ of south declinations.

A. N. SKINNER.

U. S. NAVAL OBSERVATORY.

THE PSYCHOLOGY OF SOCIETY.

THE attempt to construct a science of society by means of biological analogies has been abandoned by all serious investigators of social phenomena. It was one of those misdirected efforts that must be looked upon as inevitable in the development of any branch of knowledge. The notion of a universal evolution compelled those who accepted it to try to find some other explanation of our social relations than that dogma of an original covenant which had come down to us from Hobbes and Locke. Biology supplied most of the facts and ideas of which the evolutionary thought was constructed; and naturally, therefore, biological conceptions were first made use of in formal Sociology. At present, however, all serious work in Sociology starts from psychological data, and proceeds by a combination of psychological with statistical and historical methods.

Psychology has had a development somewhat similar. Beginning with purely metaphysical terms and reasonings, it became a natural science with the advent of evolu-

tionary thought, and for a long time drew its best materials and its most fruitful hypotheses from physiological data. Physiological Psychology was the only psychology very well worth attention. George Henry Lewes was one of the first writers to argue, as he did with great force and brilliancy in the 'Problems of Life and Mind,' that the physiological explanations of mind must be supplemented by explanations drawn from the study of society. At the present time the social interpretation of mental development is an important part of psychological activity.

Psychological and sociological investigations have thus converged upon certain common problems, namely: The problem of the social nature of the individual mind, and the problem of the psychical nature of social relations. Any new contribution to either Psychology or Sociology is likely to be found also a contribution to the other, and we may look in the near future for a number of books of which it will be difficult to say whether they are primarily works on Psychology or on Sociology.

This is eminently true of Professor Baldwin's 'Social and Ethical Interpretations,' the second volume of his work on 'Mental Development.' The first volume, on 'Methods and Processes,' was definitely a study in Psychology. The problem dealt with was that of mental development through the interaction of physical and social causes, and the importance of social factors was emphasized throughout. In the volume on 'Social and Ethical Interpretations' we again find the same problem. The development of the individual mind through its social relations and activities is further considered. In this volume, however, the opposite problem also is introduced. The development of social relations and activities through the outgoing of the individual is discussed, and the nature of society is subjected to a critical examination.

A division of the volume into two books corresponds to the above distinction of the problems dealt with. Book I. is a study of the person, public and private; Book II. is a study of society. The four formal parts of Book I. deal respectively with the imitative person, the inventive person, the person's equipment and the person's sanctions. The three formal parts of Book II. deal respectively with the person in action, social organization and practical conclusions.

I shall not attempt in the present article to review Professor Baldwin's treatment of all these subjects, or even to summarize his conclusions. I shall examine only the two conceptions that are of chief interest to the sociologist. These, of course, are the conception of the social nature of the self, or individual personality, and the conception of the psychic nature of society.

Psychology, some time ago, got beyond the conundrum

"Should I be I or should I be
One-tenth another and nine-tenths me"

if my great-grandmother had married another suitor? It seems to be agreed on all hands that in any case the ego is nine-tenths or more somebody else. That is to say, his individual personality is for the most part a product of his intercourse with other personalities. Professor Baldwin, as readers of his earlier works are aware, goes even beyond writers like Ribot and James in his account of the composite origin of the self. He holds that not only does the self incorporate elements from other personalities, so that, at any given time, it includes thoughts and feelings derived from others, and acts in imitation of the conduct of others, but also that its very thought of itself is merely one pole of a consciousness 'of a sense of personality generally,' the other pole of which is the thought of some other person or *alter*.

This comprehensive sense of personality

at first is merely projective—to use Professor Baldwin's term; it is a mass of more or less vague impressions received from persons who are encountered and observed. It is secondly subjective; the ego, by its imitations of observed persons, incorporates their peculiarities to some extent in itself. It is thirdly ejective; the self interprets observed persons in terms of its own feelings, thoughts and habits. This give and take between the individual and his fellows Professor Baldwin calls 'the dialectic of personal growth;' and he says it may be read thus: "My thought of self is in the main, as to its character as a personal self, filled up with my thought of others, distributed variously as individuals; and my thought of others, as persons, is mainly filled up with myself. In other words, but for certain minor distinctions in the filling, and for certain compelling distinctions between that which is immediate and that which is objective, the ego and the alter are to our thought one and the same thing." Thus the individual is always a *socius*, and not merely because, after reaching adult life, the necessity of cooperating with his fellow-men compels him to adapt himself to them and to modify an original egoism by the cultivation of social habits, but because, from his earliest infancy, his own development as a self-conscious person has been incorporating social elements and creating within himself a social no less than an individual point of view.

When adult life is reached, however, the process does not cease. The dialectic of personal growth continues to determine all our thinking, our social no less than our individual judgments; that is to say, in arriving at any judgment, we incorporate in our thought the judgments of other men; and we interpret the judgments of other men by our own.

It follows that all of those social relations and policies which are products of

reflection no less than of feeling are determined by the 'dialectic of personal growth,' and that, like judgments of things in general, they are, in the thought of individuals, highly composite products of subjective and ejective views of the same phenomena.

Approaching the study of society in this way, Professor Baldwin is naturally led to discriminate between the substance, content, stuff, or material of society, and the functional method or process of organization of the social material. He criticises the sociologists for not having definitely enough discriminated these two problems. Consistently with his conception of our social judgments, he describes the matter of social organization as follows: "The matter of social organization consists of thoughts; by which is meant all sorts of intellectual states, such as imagination, knowledges and informations." This 'matter,' he thinks, is found only in human groups, which only, therefore, can be called societies. Animal communities he would call 'companies.' The functional method or process of organization of the social material he is satisfied to find in the process of imitation as subjectively contained in the 'dialectic of personal growth,' and objectively described, in sociological terms, by M. Tarde. Social evolution results from the interaction of the individual as a particularizing force and society as a generalizing force. All solidarity and conservation are due to the generalizing force; all variation to the particularizing force. Progress is a dialectic of give and take between these two elements.

In examining these conceptions I shall admit their general or substantial truth, and inquire only whether they need modification, limitation or expansion. Do they sufficiently and precisely express the whole truth and nothing but the truth?

Is the thought of self quite so largely a

product of the social relation as Professor Baldwin represents? Is it accurate to say that "my thought of self is, in the main, filled up with my thought of others," even if we admit 'minor distinctions in the filling' and "certain compelling distinctions between that which is immediate and that which is objective?" What are these compelling distinctions of the immediate? Obviously, they are those presentations in consciousness which arise from organic conditions rather than from social relations. Hunger is a state of consciousness which can subvert the entire product of the 'dialectic of personal growth;' and the sociologist is unable to lose sight of the fact that when men who have been developed by that dialectic into socii are confronted by starvation they are liable to have thoughts of self which can hardly be construed as filled up mainly with thoughts of others, unless he is prepared to accept a cannibal's definition of others. The sociologist, then, must continue to think of the individual as being both an ego and a socius, and yet as being at all times more ego than socius.

The importance of this modification of Professor Baldwin's formula is chiefly for purposes of economic theory. No economist will be able to accept Professor Baldwin's contention (bottom of page 13) that it is illegitimate to 'endeavor to reach a theory of value based on a calculus of the desire of one individual to gratify his individual wants, multiplied into the number of such individuals.' The truth is that, for most purposes of economic theory, this procedure is not only legitimate, but is the only one psychologically possible. The compelling wants that political economy has chiefly to consider are those which arise from the organic nature and which, therefore, magnify the ego at the expense of the socius.

The modification is necessary also for purposes of ethical theory. Professor Bald-

win, if I rightly understand him, derives all ethical phenomena from social relations. This I believe to be an error. Economic motives are specific cravings of particular organs or groups of organs. Complete satisfaction of economic wants may deprive other organs of their due satisfaction. The protest of the neglected organs and the hunger of the entire organism for integral satisfaction is, I believe, the original source of all ethical motive, which, therefore, is indefinitely developed by, but not initiated in, the 'dialectic of personal growth.'*

It seems probable, then, that in 'the dialectic of personal growth,' the original ego with which the dialectic starts, plays throughout a controlling part; and that, after all, the process of developing a socius is one which consists essentially in modifying, by means of social relations and activities, an originally independent self.

The modification, however, is undoubtedly produced by the process of give and take between ego and alter. The question, then, that I wish next to raise is: Is the give and take, in which the ego engages, carried on indiscriminately with any alter, or is there, from the very beginning of conscious life, a tendency to discriminate between one and another alter, and to limit the conditions of personal growth by that state of consciousness which may be described as a consciousness of similars or of kind? Scattered throughout Professor Baldwin's writings are many intimations that he has suspected, or perhaps even been definitely aware of, such limitations. I do not find, however, that he has anywhere endeavored to formulate them or to bring them systematically within the formulas of his dialectic.

What, then, are some of the inquiries which should be made in regard to these limitations?

* I have considered this subject at greater length in an article on 'The Ethical Motive,' in the *International Journal of Ethics*, April, 1898.

First, I think that we should inquire whether, long before any discriminations of kind have become possible, a preparation for them and a tendency toward them is made in conscious experience. Of the sensations which first arise in consciousness some are received from the bodily organism which the self inhabits; some are received from similar bodily organisms, and some are received from wholly unlike objects in the external world. Now, we know that many sensations received from self are so nearly like sensations received from like-selves that, merely as sensations, they can be distinguished only with difficulty. If, for example, I strike with my voice a certain note of the musical scale, and another person a moment after strikes the same note with his voice, my auditory sensations in the two cases will be very nearly alike. If I cry out in pain, and then hear another man like myself cry out in pain, my auditory sensations will be nearly alike. If, however, I hear a dog bark the sensation will be different from that which I have received from my own voice. If I walk with my friend down the street, and happen to notice the motion of my feet as I take successive steps, and then to notice the motion of my friend's feet, the visual sensations will, in these two cases, be closely alike. If, however, I happen to notice the trotting of a horse that is being driven by me the visual sensation will be different from that which I have received in observing my own steps. If I stroke the back of my hand, and then stroke the back of my friend's hand, I shall receive tactual sensations that are closely alike. If, then, I stroke the fur of a cat or the mane of a horse, or touch the paw of a cat or the hoof of a horse, I shall receive sensations very different from those received from the back of my hand. It appears, then, that before there is any power to make discriminations of any kind, even to think of differences of sensation, sensa-

tions themselves fall into different groupings. At the very beginning of conscious life certain elements which are to enter into a consciousness of kind begin to appear in experience. They consist of like sensations received from self and from others who resemble self.

On the basis of these experiences there are developed others that call for investigation from the same point of view. When suggestion begins to play an important part in mental life are suggestions from persons very unlike self equally efficacious with suggestions from persons nearly like self? There is here a great field for investigation. A thousand familiar observations strongly indicate the superiority of suggestions that come from those whose neural organization resembles that of the person affected. Why, for example, does Maudsley venture to say, without offering the slightest proof, that, while men are as liable as silly sheep to fall into panic when they see panic among their fellows, they are not similarly liable when they perceive panic among sheep? Obviously, because facts of this general character are so familiar that no one would think of questioning them. In like manner, a child who objects to performing a certain task which his father asks him to do will do it without hesitation if he sees other boys in the street engaged in the same work. Phenomena like these, of course, have their origin in a like responsiveness of like organisms to the same stimulus.

A third class of experiences and activities, which are ultimately to enter into a consciousness of kind, and that are already very probably dominating 'the dialectic of personal growth,' are imitations. Here, also, there is room for exact investigation; but we may predict at the outset that investigation will verify the common opinion that we chiefly imitate our similars. The equally familiar fact that we do not always do so is of immense importance for the the-

ory of variation, invention and originality. And this theory, I believe, is not to be constructed without referring back to the truth mentioned above, that the ego is at all times the original and dominant element in the 'dialectic of personal growth.' I am not at present prepared to give my reasons, but I expect that it will be shown that in the same reaction of the organism upon the organ which is the source of ethical motive will be found the source of originality, variation and the occasional imitation of those who differ from, rather than resemble, ourselves.

The factors thus far considered, namely, like responsiveness of like organisms to the same stimulus, like sensations received from self and from others who resemble self, a greater responsiveness to suggestions from like selves than from not-like selves, and a greater readiness to imitate like selves than to imitate not-like selves, together make up the organic sympathy that is a bond of union in those groups of animals that Professor Baldwin calls companies, and the bond of union of men who act together impulsively rather than reflectively—the bond, in short, of the mob. It is certain that organic sympathy depends on organic likeness, and the phenomena that have been named above are the psychological correlatives of organic likeness.

How is organic sympathy converted into a higher or reflective sympathy? The true answer, I think, is: Through the mediation of that perception of resemblance which is the initial stage in the conversion of a mere sensational experience or likeness into a reflective consciousness of kind. When the power to perceive relations and to make discriminations arises, the perception of resemblances and differences among one's fellow-beings becomes an all-important factor in the further development of social relations and in the 'dialectic of personal growth.' From that moment organic sym-

pathy becomes a function of the perception of resemblance; and sympathy becomes, to a certain extent, reflective. Even in mob action the reaction of the perception of kind may be seen with the utmost clearness. When, for example, a mass of men simultaneously respond to a party cry or symbol the action for the moment is merely a like responsiveness to the same stimulus. An instant later, when each man perceives that his fellow-beings are, in this respect, resembling himself in feeling and in action, his own emotion is enormously intensified. It is this which gives to all symbols and shibboleths their tremendous social importance. The phenomenon has been very well described in the concluding pages of Dr. Boris Sidis's 'Psychology of Suggestion.'

Let us pass, now, to the conception of the psychical stuff or substance of society.

Professor Baldwin's thesis, as we have seen, is that "the matter of social organization consists of thoughts, all kinds of knowledges and informations." He thus places himself in definite opposition to those writers who have made sympathy, or any kind of emotion, the psychological stuff of society. It is for this reason that he makes a sharp distinction between animal 'companies' and human societies. Criticism of this thesis may be made from two points of view: one, the historical, supported by observations from animal communities; the other, the psychological, supported by those analyses of the relations of sympathy and perception which I have sketched above. From the standpoint of the observer of animal and primitive human societies it is difficult, if not impossible, to establish a line of demarcation between the more highly organized bands of animals, like troops of monkeys, or herds of elephants, or bands of wild horses, and the simplest hordes of human beings, like Bushmen or Australian Blackfellows. No one can say when, in the development of man from brute, sympathy ceased to be

the chief stuff or substance of the social relationship, and thoughts in the form of inventions and knowledges began to assume that important place. In like manner, when modern human society is looked at from the psychological view-point, it is often, indeed usually, impossible to say whether sympathy or thought predominates in the intercerebral action of the associating individuals. Professor Baldwin's thesis would compel him to maintain that the same individuals are a 'society' one day and merely a 'company' another. At one time they are thoughtful and self-controlled; at another time they are an audience swept by emotion, or a mob given over to fury. Shall we, then, say that the stuff of society is thought merely, or feeling merely, or some combination of the two? Surely the last of these possibilities is the one that is most consistent both with evolutionary hypotheses and with psychological conclusions. The substance of society at first is sympathy and instinct mainly. At its best estate society may rise to a level where thought has for the moment completely subordinated feeling. But usually, and throughout the greater part of its career, society is sympathy and instinct more or less organized, more or less directed, more or less controlled, by thought. When the thought element appears society has become reflective, and a better way to mark the distinction between the lowest and the highest societies than that which restricts the word 'society' to the latter and calls the former 'companies' is one which indicates this element of reflection. Animal and primitive human communities are, for the most part, sympathetic or non-reflective societies; progressive human communities in general are reflective societies. The reflective stage corresponds to the appearance of the perception of kind and to reflective sympathy.

But even if we were to accept the thesis that the social stuff is exclusively intellectual we could not possibly admit that it

consists of all sorts of thoughts and knowledges indiscriminately. It undoubtedly includes all sorts of thoughts and knowledges, but not all sorts of thoughts and knowledges in and of themselves make society or the social stuff. The social stuff, so far as it is intellectual, is one kind of knowledge in particular, namely, knowledge of resemblances, knowledge of those modes of like-mindedness that make cooperation possible. The same logic that leads Professor Baldwin to try to separate the social stuff from other kinds of stuff should lead him further to distinguish the thought that is essentially social and capable of organizing all other thoughts and knowledges into social material from the thought and knowledge that have no such inherent power.

Perhaps, however, it is in his few remarks about the social process that Professor Baldwin has been most unjust to himself, and has missed an opportunity to make a really important contribution to social science. He is willing to grant that the social process consists in imitation. Yet, if the earlier chapters of 'Social and Ethical Interpretations' prove anything at all, they prove that imitations are progressively controlled, as individual development proceeds, by the process of ejective interpretation. To carry this thought into sociological interpretation it is necessary to bear in mind the function of resemblance, especially of mental and moral resemblance, in controlling relationships. In the ejective processes of the 'dialectic of personal growth' not all of our acquaintances are indiscriminately utilized. We detect the difference between those who, in ways important to ourselves, resemble us and those who, in ways important to ourselves, differ from us. Our ejective interpretations, therefore, are accompanied at every step by a process of ejective selection. These ejective selections are the psychological basis of all social groupings, not only of those of the more

intimate sort, such as personal friendships, but those also of the purely utilitarian sort, like business partnerships. In a word, while imitation is a process that penetrates society through and through, it is not a distinctively social process. It is wider than the social process, just as thought is more comprehensive than the social stuff. The distinctive social process is an ejective interpretation and selection. In its widest form it includes imitation controlled by or made a function of ejective selection.

I may now very briefly indicate the further criticisms which, in pursuance of this thought, must be made upon Professor Baldwin's views—criticisms, namely, that apply to his treatment of social policy. No exception is to be taken to the analysis which describes the individual as the particularizing social force, and society in its entirety as the generalizing social force. But I fail to discover in Professor Baldwin's account of the subject any adequate recognition of the social causation of individuality. That causation must be sought in the phenomena of unlikeness in the social population. Throughout human history individuality and the possibility of social variation have been due to the commingling of ethnic elements, or, within the same nationality, to the commingling of elements long exposed to different local environments. The commingling itself is brought about by emigration and immigration. If the biological phenomenon of panmixia is all that Weismann, Galton and other investigators have represented to be, its levelling effects are counteracted and social progress is made possible only by continual groupings and regroupings in the population under the influence of ejective selection.

Finally, there is no possible explanation of social policy which leaves out of account the facts of mental and moral resemblance and the consciousness of kind. Without like-mindedness there can be neither spon-

taneous nor reflective cooperation. Not only must there be an agreement of thought, but for most, if not for all, public cooperation there must be a vast mass of sympathies and agreeing emotions. Men must have like sensations, be similarly sensitive to suggestion from resembling fellows, and enter subtly into like judgments without always being fully conscious of the process by which their conclusions are reached. The greater part of all public action must be described as a consequence of sympathetic and half-reflective agreement in plans and purposes, rather than as a consequence of systematic deliberation. Moreover, it must not be forgotten that all public policy is a means to an end, proximate or ultimate; and that the ultimate end in every case is the maintenance and development of a certain type of man. That type itself is a mode of resemblance; and the recognition of it, which directs and controls all policies, is a mode of the consciousness of kind.

FRANKLIN H. GIDDINGS.

ATOMIC WEIGHTS.

THE following table of values is recommended for general adoption in analytical

practice by a commission appointed by the German Chemical Society consisting of H. Landolt, W. Ostwald and K. Seubert. (Ber. d. D. Chem. Ges. 1898, 31, 2761.)

The commission recommends that:

1. The atomic weight of oxygen be taken as 16.000, and that the atomic weights of the other elements be calculated on the basis of their combining ratios with oxygen, directly or indirectly determined.

2. The following atomic weights of the elements be adopted in practice, as they are probably the most correct values known at the present time.

These numbers are, as a rule, given only with so many decimals that even the last one may be regarded as accurate. In consequence, the atomic weights determined by Stas, in which the errors amount to from 3 to 6 units in the third decimal, are given with two decimals; the other atomic weights which have been more accurately determined are given with one decimal, and those less accurately determined are given without decimals. Exceptions to this rule have been made only in the cases of nickel, bismuth and tin, marked with an asterisk in the table.

Name.	Symbol.	Atomic Weight.	Name.	Symbol.	Atomic Weight.	Name.	Symbol.	Atomic Weight.
Aluminium.....	Al	27.1	Helium (?).....	He	4.	Rubidium.....	Rb	85.4
Antimony.....	Sb	120.	Hydrogen.....	H	1.01	Ruthenium.....	Ru	101.7
Argon (?).....	A	40.	Indium.....	In	114.	Samarium (?).....	Sa	150.
Arsenic.....	As	75.	Iodine.....	I	126.85	Scandium.....	Sc	44.1
Barium.....	Ba	137.4	Iridium.....	Ir	193.0	Selenium.....	Se	79.1
Bismuth.....	Bi	208.5*	Iron.....	Fe	56.0	Silicon.....	Si	28.4
Boron.....	B	11.	Lanthanum.....	La	138.	Silver.....	Ag	107.93
Bromine.....	Br	79.96	Lead.....	Pb	206.9	Sodium.....	Na	23.05
Cadmium.....	Cd	112.	Lithium.....	Li	7.03	Strontium.....	Sr	87.6
Cæsium.....	Cs	133.	Magnesium.....	Mg	24.36	Sulphur.....	S	32.06
Calcium.....	Ca	40.	Manganese.....	Mn	55.0	Tantalum.....	Ta	183.
Carbon.....	C	12.00	Mercury.....	Hg	200.3	Tellurium.....	Te	127.
Cerium.....	Ce	140.	Molybdenum.....	Mo	96.0	Thallium.....	Tl	204.1
Chlorine.....	Cl	35.45	Neodymium (?).....	Nd	144.	Thorium.....	Th	232.
Chromium.....	Cr	52.1	Nickel.....	Ni	58.7*	Tin.....	Sn	118.5*
Cobalt.....	Co	59.	Nitrogen.....	N	14.04	Titanium.....	Ti	48.1
Columbium.....	Cb	94.	Osmium.....	Os	191.	Tungsten.....	W	184.
Copper.....	Cu	63.6	Oxygen.....	O	16.00	Uranium.....	U	239.5
Erbium (?).....	Er	166.	Palladium.....	Pd	106.	Vanadium.....	V	51.2
Fluorine.....	F	19.	Phosphorus.....	P	31.0	Ytterbium.....	Yb	173.
Gallium.....	Ga	70.	Platinum.....	Pt	194.8	Yttrium.....	Y	89.
Germanium.....	Ge	72.	Potassium.....	K	39.15	Zinc.....	Zn	65.4
Glucium.....	Gl	9.1	Præsdodymium (?)..	Pr	140.	Zirconium.....	Zr	90.6
Gold.....	Au	197.2	Rhodium.....	Rh	103.0			

In the case of nickel this was done in order to emphasize the difference between the atomic weights of cobalt and nickel, although in both values there may be possible deviations of ± 0.2 . The true atomic weights of bismuth and tin are not correct to a certainty, to within 0.1. The value of hydrogen is 1.008, correct to within 0.001, but the approximation of 1.01 has been regarded as permissible for the requirements of practice, as it involves an error of only one-fifth of one per cent. The values given for the elements marked in the table with interrogation points are not necessarily exact within whole units of the atomic weights assigned.

FERDINAND G. WIECHMANN.

JOHN CUMMINGS.

IN the decease of Hon. John Cummings, of Woburn, Mass., on the 21st of December, there terminated a life which has been noteworthy for the encouragement it has given to the study and teaching of science. In the early part of his manhood days Mr. Cummings acquired a reputation for honorable dealing and for his success in the manufacture of leather in his native town of Woburn. To that town he was always loyal and generous, but his intelligence and his activity led him into larger circles until he became favorably known and his influence was felt in a large and populous community. He became acquainted with the late William B. Rogers, for whom he always cherished an admiration and a profound regard. He also knew Louis Agassiz, Jeffries Wyman, Asa Gray and others, and he soon became a student as well as a lover of nature. The offices of trust and of business responsibility which he filled make a long and notable list, but his large affairs did not prevent him from cultivating a love for science, and they aided him in multiplying his gifts to the cause of education. Through his attachment for William B.

Rogers he was interested in the founding of the Massachusetts Institute of Technology, and he became one of its most substantial supporters, contributing to its financial needs and serving as its Treasurer for 17 years. It was through his generosity that the Boston Society of Natural History started its 'Teachers' School of Science,' and it was through his liberality that its botanical collection was developed and that it has received special care to the present day. He was actively and generously interested in the work of public instruction, and he extended his aid to the South after the close of the Civil War. In one instance he purchased a building and supplied teachers, urging them to work for the establishment of free public schools, and when this was about to be accomplished he donated the building to the cause. His gifts and his efforts were never calculated to attract attention to himself, and many of his good deeds were scarcely known even by his friends. He was one of a class of honorable and broad-minded business men who have been magnanimous in their support of science education, and who have found time to participate in the acquisition of knowledge, while aiding others to means for the prosecution of their studies or investigations.

WM. H. NILES.

SCIENTIFIC BOOKS.

Matter, Energy, Force and Work. By SILAS W. HOLMAN, Professor (Emeritus) Massachusetts Institute of Technology. New York, The Macmillan Company.

Lovers of exact science are already indebted to Professor Holman for numerous important contributions to our knowledge of physics and especially for valuable suggestions as to the best treatment of the experimental solution of physical problems. His most pretentious work thus far is that on 'Precision of Measurements,' which is everywhere recognized as a standard and which ought to be in the hands of every

one who is preparing to do something in the way of experimental research. In the volume now under consideration he has entered a different field, and with such success as to deserve and, I have no doubt, to win the approval of all interested in the fundamental principles and concepts of physical science. In addition to an excellent review of current theories of the nature of matter, energy, force, etc., in which the vortex theory and Le Sage's theory of gravitation are exceptionally well presented, the work includes much that is new and original, a few proposed additions to the nomenclature of science and many extremely suggestive discussions.

Professor Holman departs from the usual practice in the very beginning when he defines matter as 'the inert constituent of substance.' By 'substance' he means 'that which is inferred as existing in space, and as endued with powers to affect portions of itself,' and it is made out of matter by the addition of something. 'Continuous, uniform and permanent occupancy of space' is the ultimate and sole property of matter. 'Mass' is defined as 'quantity of matter,' and as matter has really no significance until it becomes 'substance' the word 'mass' is practically banished.

Atoms are 'permanent aggregations of matter differentiated from matter by some mode of motion' (vortex motion), and they combine to make 'substance.' 'Bodies' are limited portions of 'substance.' The 'something' which distinguishes *substance* from *matter* is *energy*. "A designated quantity of substance consists of a definite quantity of matter in permanent association with a definite quantity of energy or motion." The two words 'or motion' render this statement somewhat obscure. What is meant by a 'definite quantity of motion?' Professor Holman's definition of 'motion' is that of nearly all writers, namely, 'change of relative position.' It is a curious but common practice to define it in this way and then to define its 'quantity' by associating with it something (matter, mass) absolutely unlike it in every respect. It is certainly not in this sense that he means to use it in the phrase above quoted.

To all 'substance' he attributes a 'capacity

for kinetic energy' and to this capacity he applies the term '*kinergety*,' of which much use is made in all subsequent discussions. Mass is *assumed* to be proportional to *kinergety* and the latter thus affords a means of measuring the former or rather of comparing different quantities of it.

Quantities of substance may also be compared by means of the force called 'weight,' and a quantity thus determined by means of the equal-arm balance is called *weightal*.

The 'International Kilogramme' and the 'Imperial Pound' are spoken of as standards of '*Kinergety*' and *weightal* is shown to be proportional to '*Kinergety*.' What is commonly known as 'the ether,' the medium by which radiant energy is transmitted, is regarded as a kind of substance, and hence *not* the continuous uniform substratum of 'matter' from which all substance is evolved.

It is impossible in a brief notice to make extensive quotations, but especial attention ought to be invited to the author's remarks on the various forms of energy. They are extremely interesting and suggestive, and particularly so in the exhibit which is made of the importance of the energy of elasticity as an intermediate stage of all energy transformations. The definition of 'force' as related to energy will not fail to attract attention and possibly enable many readers to possess a reasonably satisfying concept of that much-abused word. Reference has already been made to the very full presentation of the vortex theory of matter, in the possibilities of which the author evidently has great confidence. The principal results of the splendid work of Professor J. J. Thomson in the application of this theory to chemical phenomena are here given in clear and simple language, without the mathematical backing upon which it leans. The singularly clear and satisfactory discussion of Le Sage's theory of gravitation as affected by the vortex theory of atoms would alone put the volume on the shelves of every physical library, but the more distinctly original portions of it, the nature of which has only been hinted at in this notice, will fully justify its careful perusal by students of physical science.

I think there can be no impropriety in a brief

word in reference to the circumstances under which this book was written. It is well known among his many friends that Professor Holman's active participation in the work of the Rogers Laboratory of Physics was arrested two or three years ago by the development of an illness from which, unfortunately, he has not yet recovered. During this time he has been confined to a reclining chair, and, in his own characteristic words, 'even the familiar utilization of the convenient gamut of ether waves' has been denied. Although unable to move and unable to see, his courage has never faltered. There has been no loss in his power of thought, and he has gone on thinking the many fine things which he has put into this book, for which, even if it had not been prepared under conditions that would have defeated most men, all physicists, friends and strangers alike, will ever be his debtor.

T. C. M.

A Brief Course in Qualitative Analysis. By ERNEST A. CONGDON, PH.B., Professor of Chemistry in the Drexel Institute. New York, Henry Holt & Co. 1898.

The method of treatment adopted in this book consists in giving, first, a clear, concise statement of the most important reaction for each metal and acid, and then tables giving one or more schemes of analysis for each group. The tables are supplemented by explanatory notes. At the end of the book a series of questions, well designed to test the student's grasp of the subject, are given. While the tabular form always has the advantage of presenting the scheme for analysis very clearly, in the opinion of the writer, the same object is better attained by a tabular record prepared by the student. Because of their concise form, tables necessarily omit many details which are essential for the successful execution of an analysis, and the notes which follow do not entirely overcome this difficulty.

The selection of reactions and of schemes for analysis is excellent, and in the hands of good teachers the book will prove a useful one.

A Short Manual of Analytical Chemistry, Qualitative and Quantitative, Inorganic and Organic, following the Course of Instruction given in

the Laboratories of the South London School of Pharmacy. By JOHN MUTER, PH.D. Second American Edition. Illustrated. Adapted from the Eighth British Edition. Philadelphia, P. Blakiston's Sons & Co. 1898. Pp. xiii + 228. Price, \$1.25.

As the title implies, a very large amount of information is compressed into comparatively little space in this volume. In the qualitative portion the statements giving the deportment of metals and of acids toward reagents are given consecutively and are followed by tables of schemes for analysis. Then follow directions for the identification of alkaloids and of a number of common organic compounds. The quantitative portion includes volumetric and gravimetric analysis, ultimate organic analysis, and directions for the examination of air, water, food, alcoholic liquors, etc. It is in this portion that American chemists will find most to criticise; Gooch crucibles are nowhere described, not even for the cases where they should be used in place of weighed filters. Directions for the determination of 'citrate soluble phosphoric acid' are not given under the analysis of 'mannures,' and no reference is made to the 'official methods.' The old uranium acetate method is given for the volumetric estimation of phosphoric acid instead of the more satisfactory methods with a reductor or with a standard alkali. Metaphenylene diamine is recommended for the detection of nitrites in water analysis, although the reagent is not sufficiently sensitive to be of any practical use in many cases. But, while the authors do not appear to be conversant with the best American practice in these and some other cases, and while some of the directions appear to be too much abbreviated for the satisfactory use of a beginner, it would be difficult to find another book which compresses so much information about analysis into so small a space and for so moderate a price.

W. A. NOYES.

Wild Animals I have known. By ERNEST SETON THOMPSON. New York, Charles Scribner's Sons. 1898. Square 12mo. Pp. 359. 200 illustrations. Price, \$2.00.

Rarely are the qualities of naturalist, writer and artist combined in one person, but Mr.

Ernest Seton Thompson has won distinction in all three rôles. As a naturalist he has enjoyed opportunities for study and observation both in Canada and the United States, chiefly in Ontario, Manitoba and New Mexico. As a writer he is known as the author of 'Birds of Manitoba,' 'Mammals of Manitoba,' and numerous articles contributed to magazines and scientific journals. As an artist he is perhaps still more widely known through his 'Art of Taxidermy,' and work in illustrating several popular books on natural history, more especially on birds.

His latest book is original in conception and execution. Here he has brought together some of his most interesting adventures and field experiences, woven them into entertaining and instructive stories, and illustrated them in a manner entirely unique. Under the title of 'Wild Animals I have known' Mr. Thompson has departed from the beaten path of natural history description, and given us an insight into the habits and daily lives of some of the lower animals with which he has been on more or less familiar terms. He describes his friends from what might be termed the human standpoint, *i. e.*, not as mere objects, but as individuals endowed with personality and reason. "What satisfaction," he asks in the prefatory note, "would be derived from a ten-page sketch of the habits and customs of Man? How much more profitable it would be to devote that space to the life of some one great man. This is the principle I have endeavored to apply to my animals."

The book consists of eight stories detailing the adventures of Lobo, King of Currumpaw; Silverspot, a crow; Raggylug, a rabbit; Bingo and Wully, two dogs; The Springfield fox; the pacing mustang; and Redruff, a partridge. Lobo was a large wolf well known to the cattlemen of northern New Mexico who suffered from his depredations; Silverspot, an old crow, has received his name on account of a conspicuous white spot on the side of his head; Raggylug, a rabbit with a ragged ear. Each animal and bird had some peculiarity by which it could be readily distinguished and thus kept under observation, sometimes for several years. The stories are told in a delightfully interesting style and contain many new facts and observa-

tions. Nearly all end tragically, for, as the author explains, the end of a wild animal is usually tragic. The book is not, and is not intended to be, a scientific treatise on mammals. The reader is assured that the stories are true, but this does not necessarily imply that every detail was based on actual observation. In fact, it would be practically impossible to observe some of the scenes depicted in the biographies of the rabbit and the fox. In describing the habits of a particular animal there is little more than a skeleton of fact on which to build. The record is so fragmentary that an author is compelled to fill in the gaps from his general knowledge of the species and to represent the characters as he conceives them to be. Such descriptions are of necessity composite and subject to personal equation and imagination.

The book is copiously illustrated with 29 half-tone plates and a large number of marginal sketches. The type bed is narrow and the margins are utilized for sketches which are sometimes mere outlines or suggestions, but so skillfully executed as to make it possible to follow certain parts of the story merely by the illustrations. No one can fail to notice the author's careful attention to details and his skill in woodcraft. The student of natural history will find many things of interest in the descriptions and illustrations, and the general reader will not regret an introduction to some of the animals Mr. Thompson has known.

T. S. P.

Human Anatomy. Edited by HENRY MORRIS, M.A. Philadelphia, P. Blakiston's Sons & Co. 1898. Second Edition.

The appearance of a revised and enlarged second edition of this work within less than six years from its original entry into the arena is in itself a sign of success. The well-known textbooks of human anatomy which have held almost undisputed sway since the memory of the oldest teacher, continually enlarging their field with the lapse of years, are so strongly entrenched that the prospects of a new rival at first can hardly have appeared hopeful. Not only have they done their work very well, but their methods have become so familiar to teachers, and the latter have got so habituated to

them, that a new text-book is like a new pair of shoes, which have to be broken in before they can be called a comfort to their owners. There can be no question that this process is likely not to be a very rapid one. It is clear that this book has stood this preliminary test. It is written by several authors, but is fairly homogeneous. The aim is to disregard microscopic anatomy and to offer a text-book which shall present the facts of gross anatomy both in a practical and in a scientific way. It is needless to say that the latter requires references both to embryology and to comparative anatomy. The section on the bones by Sutton is remarkably well done. When we say that the joints are the work of the editor we have said enough to vouch for excellence—to all, at least, who know his earlier monograph (now unhappily out of print) on that subject. The peritoneum is the work of Treeves, which, again, is saying enough. We mean no slight to the other able writers whom we do not more particularly mention. The first edition concluded with a section on surgical and topographical anatomy which cannot but be welcome. In the present edition this is followed by a too short chapter on vestigial and abnormal structures. Variations of the muscles, of the vessels, and some of those of bones are considered in their respective sections. The book is a very good one. We could, perhaps, find flaws here and there, but a search for them is uncalled for, as most of our readers are not professed anatomists. We have but one serious criticism to make, namely, that in the section on the nervous system the most recent (but generally accepted) fundamental doctrines of the structure of that system have not received due recognition.

The illustrations are a most important part of a text-book on anatomy. We are happy to give these very high praise. We were on the point of making special mention of those of certain sections, but they are so good as a whole that we refrain.

To what extent this book will displace old and established favorites the future will show. It is a matter eminently unsafe to prophesy about, but the success already attained is, no doubt, an earnest of future progress.

THOMAS DWIGHT.

GENERAL.

THE proceedings of the forty-seventh meeting and fiftieth anniversary of the American Association for the Advancement of Science have been sent to members by the Permanent Secretary, Dr. L. O. Howard. The volume, which contains introductory matter extending to 83 pages and 658 pages of text, appears very promptly, the address of President Eliot given before the Association on 'Destructive and Constructive Energies of our Government compared,' being here printed before the January issue of the *Atlantic Monthly*, which also contains it.

LADY WELBY has printed for private circulation a pamphlet extending to 61 pages, entitled 'The Witness of Science to Linguistic Anarchy.' The introduction opens with the statement: "The following collection of extracts, chiefly from *Nature*, *SCIENCE* and *Natural Science* have been selected from a much larger number, with the object of bringing together, in convenient form, evidence of an almost incredible state of things in the scientific world." We find an interesting collection of quotations on scientific nomenclature, showing a certain amount of diversity and conflict. Still they scarcely bear witness to a 'paralyzing nightmare of impotence,' and it does not follow as suggested by Professor Foster that an international tribunal should 'stamp the coin of science' by defining every new name. New words must come and language must be flexible if science is to grow. Certainly men of science should realize their responsibility and be careful in their use of terms, but words were made for science and not science for words. Those interested can probably obtain a copy of Lady Welby's pamphlet by addressing her at Denton Manor, Grantham, England.

WE have received for review a copy of 'Life's Comedy,' Third Series (Charles Scribner's Sons). *Life*, from the issues of which this Christmas book is a reprint, does not hesitate to leave its own field and display ignorance by attacking men of science who practice vivisection, which should warn us against trespassing on foreign territory. As *Punch* treats the anti-vivisectionists from the point of view that commends itself

to men of science, we may be prejudiced, but it does seem that 'Mr. Punch' is always a gentleman, whereas *Life* is on occasion distinctly vulgar.

THE Rev. J. G. Hagen, of the Georgetown College Observatory, announces that the first series of charts of his Atlas of Variable Stars is nearly printed and will be issued in a few weeks. The cost of engraving and printing the whole Atlas will be about \$7,000 and, though one-fourth of this sum has been given by Miss Catherine Bruce, it is necessary that one hundred subscribers to the entire series be obtained in order that expenses of engraving and printing can be guaranteed and its completion secured. The present series contains twenty-four charts and is sold to subscribers to the whole series at one Mark per chart. The work is published by Herr. F. L. Dames, of Berlin, but subscriptions may be sent through the Harvard College Observatory or through the Georgetown College Observatory.

SCIENTIFIC JOURNALS AND ARTICLES.

Terrestrial Magnetism for December, 1898, contains the following articles: 'Report of the Permanent Committee on Terrestrial Magnetism and Atmospheric Electricity to the International Meteorological Conference,' 'The Toronto Magnetic Observatory,' R. F. Stupart; 'The Attitude of the Aurora above the Earth's Surface' (concluded), C. Abbe; 'Bigelow's Solar and Terrestrial Magnetism,' reviewed by Arthur Schuster; 'Notes on the Magnetic Storm of November 21st-22d, and on the Secular Motion of a Free Magnetic Needle,' by L. A. Bauer. Mr. Stupart in his article describes the new Toronto Magnetic Observatory, situated at Agincourt, nine miles northeast of the old and disturbed site. Beginning with March, 1899, the name of the journal is to be changed to *Terrestrial Magnetism and Atmospheric Electricity*. It has been found necessary to enlarge the periodical somewhat, and, in consequence, the subscription price has been increased from \$2 to \$2.50. It will be conducted, as heretofore, by L. A. Bauer and Thomas French, Jr., both of the University of Cincinnati. The editors will be assisted by Messrs. Eschenhagen (Pots-

dam), Moureaux (Paris), Littlehales (Washington), Schuster (Manchester), Elster and Geitel (Wolfenbüttel), McAdie (New Orleans), and by an international council consisting of Rücker (England), von Bezold (Germany), Mascart (France), Rykatschew (Russia), Mendenhall and Schott (America).

The American Journal of Science for January contains the following articles:

'Thermodynamic Relations of Hydrated Glass,' by C. Barus; 'Platinum and Iridium in Meteoric Iron,' by J. M. Davison; 'Studies in the Cyperaceæ,' by T. Holm; 'Regnault's Calorie and our Knowledge of the Specific Volumes of Steam,' by G. P. Starkweather; 'Estimation of Boric Acid,' by F. A. Gooch and L. C. Jones; 'Descriptions of imperfectly known and new Actinians,' with critical notes and other species, II.; by A. E. Verrill; 'Mineralogical Notes,' by W. F. Hillebrand; 'What is the Loess?' by F. W. Sardeson; 'Absorption of Gases in a High Vacuum,' by C. C. Hutchins.

Appleton's Popular Science Monthly for January gives as a frontispiece a portrait of August Kekulé and a sketch of his life and contributions to science follows. Among the other articles in the number are 'The Mind's Eye,' by Professor Joseph Jastrow, illustrating the part played by mental processes in visual perception; an argument by Professor G. T. W. Patrick, maintaining that children under ten should not be taught to read and write; and nature study in the Philadelphia Normal School, by Mrs. L. L. W. Wilson.

SOCIETIES AND ACADEMIES.

THE NEBRASKA ACADEMY OF SCIENCES.

THE ninth annual meeting of the Nebraska Academy of Sciences was held at Lincoln, November 25 and 26, 1898.

The address of the retiring President, Dr. H. B. Ward, was upon the 'Fresh-water Biological Stations of the World.'

These were divided into individual resorts for independent investigation, periodical resorts where groups of scientists go for a portion of the year, and permanent stations where work is carried on throughout the year by resident investigators. The best results can only be expected in the latter class, which are necessarily under government protection.

On the evening of November 25th, after a banquet tendered to members of the Academy and their wives by the Lincoln members, an address was given before the Academy by Professor Lawrence Bruner, on the 'Flora and Fauna of Argentina, S. A.,' where he has spent the past year investigating a grasshopper plague.

Professor Bruner first gave a few facts regarding the location and shape of Argentina, its climate and the effect of the climate on plant and animal life. A very large portion of Argentina has an average of less than eight inches of rainfall per annum; another portion has an average rainfall of from eight to twenty-four inches, while another has from twenty-four inches to sixty. Still all this territory is inhabited and is well supplied with plant and animal life. Here evolution in plant and animal life is most noticeable, every form of vegetation and all kinds of animal life changing as the climate changes in traveling from one portion of the country to the other. Argentina was a country where everything protected itself and was fitted by nature to do so. The trees had thorns, the grasses and weeds were provided with thorns, and pointed, sharp blades and herbaceous plants were shielded with burrs. In the driest parts of Argentina Professor Bruner said he had found plant and animal life abundant. Forests of large trees could be found where rain was scarcest, and he had been told that when heavy rains fell the trees would die from too much moisture. Many forms of animal life thrived best where there was no moisture. Plants were found without leaves, and birds of the same order as our water fowl that avoided water. In no other country on the earth, excepting perhaps Australia, could forms of animal life be found that compared with what was to be found there. Many kinds of birds were provided with spurs on their wings, and to illustrate some of these wonders the stereopticon was introduced and a number of views of strange animal life shown.

Other papers on the program were as follows: 'Methods of Collecting and Preserving Water-Mites,' by Dr. Robert H. Wolcott, with exhibition of new forms of collecting apparatus. 'The Discovery of the Southern Maidenhair Fern in the Black Hills,' by Dr. Charles E. Bessey. It had been reported to him that it

grew there in profusion, but as its northern limit was about 36 degrees, or the southern line of Missouri, he took a thousand-mile journey that he might be able to state scientifically that it was there. He found it growing in profusion on the banks of a stream fed by warm springs, beside the buffalo berry of the north.

C. J. Elmore read the second chapter of his serial, begun last year, on 'The Second Year's Flora of a Dried-up Millpond,' and was requested to continue the subject next year.

'One to One Correspondence,' by Dr. Ellery Davis. 'A Determination of the Latitude of the Observatory,' by Professor G. D. Swezey. The reduction of fifty-nine observations for the latitude of the observatory on the University grounds, made with a small universal instrument, gave as a result $40^{\circ} 49' 9''.9 \pm 0''.4$. Over a hundred additional observations have been taken which have not yet been reduced.

A joint paper by Abel A. Hunter and G. E. Hedgecock on 'Thorea,' a seaweed found by Mr. Hunter in the northeastern part of Lancaster county the past summer, was submitted. This very rare and exceedingly interesting seaweed is now found for the first time in Nebraska and the second time with certainty in North America.

'What is Phytogeography,' by Dr. Roscoe Pound. A discussion of the province of phytogeography and of the various names that have been used to designate this and other closely related lines of investigation.

'The Growth of Children,' by Dr. William W. Hastings. Observations made in European cities and in the larger cities of this country, with the results of experience in the University and public schools of Lincoln. From two to sixteen years the growth of children is very regular, but from sixteen to seventeen it is retarded. The full growth of man does not cease until after he is twenty-five. Athletics extend the growing period to thirty years. Affluence increases and deprivation and hard work decreases the growth. Size diminishes between the age of fifty and sixty. The speaker mentioned the phenomenal increase of five and seven-eighths inches chest measure in a 15-year-old boy, but the discussion brought out the fact that his grade marks were only seventy-five.

Ernest A. Bessey, in 'How some Pistils close up,' gave a study of the pistils of the buttercup and larkspur.

'Observations on the Leonid Meteors of 1898,' by Professor G. D. Swezey. Observations made simultaneously at Lincoln, Crete and Beatrice, from which the heights and actual paths of a number of the meteors was determined.

A. B. Lewis read a paper on 'The Occurrence of a Fresh-water Nemertine in Nebraska,' which described a marine animal which has been discovered in fresh water near the round house.

Miss Carrie Barbour showed geodes from the Bad Lands, formations which are called by the cowboys blossom-stones.

Notes on the 'Falling of Leaves from a Cottonwood Tree,' by C. J. Elmore, described a tree sixteen inches in diameter and forty-five feet high. The cottonwood was shown to adapt itself to climates and conditions and to be unaffected by the change of seasons.

Dr. R. H. Wolcott, of the zoological department, read a paper on 'The Hydrachnidæ of Nebraska.' He had already found sixteen new species and one new genus.

The geology of Lincoln's surroundings, as described last year by C. A. Fisher, was illustrated by charts and outlines by Miss Barbour.

The following papers were read by title only: 'Botanical Notes for the Year 1898,' by Dr. C. E. Bessey. 'Fossil Bryozoans of Nebraska,' by Mr. G. E. Condra. 'Some new Grasshoppers and other related Insects from Argentina,' by Professor Lawrence Bruner. 'A new Bird Tape Worm,' by Mr. Geo. E. Condra. 'On the Poisonousness of Pure Water,' by Dr. A. S. von Mansfelde. 'Obituary of Professor Wells H. Skinner,' by Mr. A. T. Bell.

The following persons were elected to honorary membership in the Academy: Alexander Agassiz, LL.D.; John M. Coulter, LL.D.; Professor Samuel H. Scudder; Joseph Le Conte, LL.D.; Simon Newcomb, LL.D.; Dr. Otto Kunze; Professor Victor Hensen.

The election for officers resulted as follows: President, Professor G. D. Swezey, of Lincoln; Vice-President, Dr. H. Gifford, of Omaha; Secretary and Custodian, Professor Lawrence Bruner, of Lincoln; Treasurer, G. A. Loveland; Directors, Professor Charles Fordyce, of Univer-

sity Place, and Professor J. H. Powers, of Crete; Professor H. Brownell, of Peru.

SCIENCE CLUB OF NORTHWESTERN UNIVERSITY,
EVANSTON, ILLINOIS.

At the December meeting of the Science Club, of Northwestern University, Professor A. R. Crook, of the department of mineralogy, read a paper on 'Notes on Russian Geology.'

Until within recent years the number of Russians working in geology has been insignificant. The results of their work have for the most part been published in a language inaccessible to non-Russians. The police barrier erected by the government against travelers has kept out foreign geologists. Hence our knowledge of Russian geology has been meagre. The meeting of the International Geological Congress in St. Petersburg was an event of great importance. A hundred workers from other lands visited mines and formations from one part of the country to the other, and thus gained a personal knowledge of Russian geology, an acquaintance with the tasks and methods of work of Russian geologists, and an inclination to learn the Russian language. Russian geology offers interesting material in paleontology, mineralogy and general geology. The first contains less of importance than the last two.

The topaz, turmaline, emerald, alexandrite, phenacite, amethyst, rhodonite, malachite, platinum, gold and a hundred other less valuable minerals found in the Urals shed light upon the association, occurrence and genesis of minerals, while exhibiting the species in most perfect form.

The crystallines and eruptives of Finland and the Urals, the question of the Silurian in the Urals, the development of the Permian, the Carboniferous of South Russia, the igneous rocks of the Caucasus, together with their present glaciers, and the glacial deposits which cover the larger part of Russia, court investigation and attract the petrologist, the glaciologist, the stratigrapher, the physiographer, the paleontologist.

Natural and cut gems, maps and lantern slides were used in illustration.

WM. A. LOCY,
Secretary.

THE CHEMICAL SOCIETY OF WASHINGTON.

THE regular meeting was held on November 10, 1898.

The first paper of the evening was read by Mr. F. K. Cameron, and was entitled 'Some Boiling-point Curves for Mixtures of Miscible Liquids.' The general properties and significance of pressure-concentration and temperature-concentration curves for pairs of perfectly miscible liquids were indicated, and the researches of Konowaloff, Nernst and others briefly cited. All the possible types now known were illustrated by some as-yet-unpublished data from a preliminary investigation by Cameron and Thayer. A significant fact brought out by certain of these curves, notably the one for alcohol-chloroform mixtures, is that they possess not only a maximum and minimum point, but there is a decided sag in the opposite direction at another portion of the curve. So far no such curve is known which has both a maximum and minimum point, and the possibility of such a case has been denied by some authorities. But the fact just cited shows an indubitable tendency towards such a case and indicates that by a suitable choice of the constant factor (temperature or pressure) for some pair of liquids such a curve may yet be found. The great desirability of further experimental work in this field, both for theoretical and practical reasons, was indicated.

The second paper was by Mr. F. K. Cameron, and was entitled 'A Ternary Mixture.' Given a mixture of two perfectly miscible liquids, A and B, and a third substance, C, soluble in one constituent of the pair, at a definite temperature there will be a separation of the liquid mixture into its constituents, this definite temperature being dependent on the relative concentrations of the solution. By keeping C in excess of the amount soluble the problem is somewhat simplified. The results of a preliminary investigation on the curve for temperature of separation-concentration, presence of a third substance soluble in only one constituent, were presented. Further, the third substance, C, was varied for certain concentrations. And, finally, mixtures of the substances which had been used as C were tried. The results were interesting, but

no causal connection could be detected. It is essential that more experimental evidence shall be in our possession before a satisfactory theory of the phenomena will be possible.

The third paper was read by Dr. T. M. Chatard and was entitled 'Note on the Rate of Loss in Cyanide Solutions.' Dr. Chatard exhibited a sheet of curves representing the rate of loss of cyanide in solutions used for the extraction of gold in the electrolytic sluice. There is always a certain loss due to oxidation of the cyanide through agitation of the solution during the operation of the apparatus. Another loss results from the action of the ore on the solution. An electric current of about 0.2 amp. per sq. ft. of cathode plate and of about 2 volts is employed, and it is desirable to know what effect such a current has upon the solutions which usually contain from 0.20 to 0.25 per cent. KCN at the start. Samples of the solution were taken at regular intervals during each run, the percentage of cyanide giving points of the curve. When ore is treated, the curves usually show a rapid loss of cyanide during the first period of fifteen minutes, due to the action of the ore, the rate of loss then decreasing so that the final result is often a fairly regular curve. When the solution is run with neither ore nor current the fall in strength is usually regular, so that the line connecting any three consecutive points is practically straight. Using the customary current but no ore, other conditions being alike, the results indicate that the cyanide losses are lessened even though the tests are, as yet, too few for positive evidence. It may, however, be stated with confidence that the use of electricity, so important for the extraction of precious metals from ores and solutions, is not attended by any increased loss of the expensive cyanide.

The last paper was read by Dr. C. E. Munroe and was entitled 'The Examination of Acid for Use in the Manufacture of Gun-cotton.' Dr. Munroe's paper contained a summary of work done by his assistants, Mr. G. W. Patterson and Mr. J. J. Tobin, and by him. The specifications for the acids given were accompanied by descriptions of the analytical methods and methods of calculation to be followed in the inspection of the acids supplied, and a com-

parison was made between these methods and others that have been proposed. Attention was called to the necessity of defining the substances present by the methods by which they are to be determined and reckoned, as it not infrequently happens that there are differences of opinion as to the form in which they occur and the methods for determining them, and a dispute is most easily avoided by a prior technical convention. Thus there is a difference of opinion as to the form in which a portion of the nitrogen present in these acids occurs, some regarding it as in the form of hyponitrous acid, others as nitrosulphuric acid, but without expressing any opinion on this point the specifications simply required that it should be determined in a carefully prescribed manner and reckoned as N_2O_4 , and that as thus determined and reckoned it should not exceed a certain percentage of the mixture. The data of a considerable number of analyses showing the percentage composition and specific gravities of both original acids and spent acids from the gun-cotton manufacture was given, and the differences between the amounts of sulphuric acid in the different operations was seen to be remarkably constant, showing the mixture to be well proportioned for this purpose. Observations were made on the permanency of composition of the mixed acids stored in darkness and in sunlight; on the color of the acids as a criterion of the amount of nitrogen oxides present; on the change of color produced by heating them; on the freezing of the acids and the rate of expansion of different mixtures. The specific-gravity bottle used, which was devised by Professor Barker, and which was particularly adapted to this work, was exhibited.

WILLIAM H. KRUG,
Secretary.

HARVARD UNIVERSITY: STUDENTS' GEOLOGICAL CLUB, DECEMBER 6, 1898.

MR. P. S. SMITH described 'An Occurrence of Corundum in Kyanite.' This paper will be published soon in full. Mr. J. M. Boutwell spoke on 'Tides: Their Character and Cause.' After reviewing our incomplete knowledge of tides in the open ocean, he explained a method of expressing, with plotted curves, certain facts

obtained from observations on tides, as they traverse continental shelves and estuaries. These curves show a perfect homology between wind waves and true tidal waves in form, range, length (better termed breadth) and velocity. Under the cause of tides, the main points of the explanation advocated by Hagen, Airy, Darwin and others were presented.

Geological Conference, December 13, 1898.—In a communication entitled 'Dikes and Veins,' Professor Shaler considered the origin of fissures occupied by these bodies. Field observation near the Spokane Placer, Montana, shows that intrusives part rocks along bedding planes more readily than transverse to them. Professor Shaler suggests that water, mechanically included in beds at the time of their deposition, becomes heated by an approaching, intrusive mass; and that by expanding it opens the way for the intrusion along previously existing, structural planes. According to this theory, in a region where the intrusives are of different age, the earliest intrusive should show evidence of its easy entrance along fissures opened by expanded water; and subsequent intrusives should exhibit signs of more difficult entrance, owing to the exhaustion of assisting waters.

Mr. Robert DeC. Ward presented 'Some Observations on the Médanos of Peru,' which will be published in a future issue of this JOURNAL.

J. M. BOUTWELL,
Recording Secretary.

TORREY BOTANICAL CLUB, NOVEMBER 30, 1898.

ON discussion of enlargement of the program for excursions, it was arranged that field meetings be provided on Saturdays after the first of January, for the purpose of studies of cryptogams and of winter stages of higher plants.

The first paper was by Mr. Marshall A. Howe, 'Remarks on some Undescribed Californian Hepaticæ,' and consisted of the description of three new species, soon to be published. Beautiful plates illustrating these species were exhibited, the work of Mr. Howe, to form part of the forthcoming volume of the Memoirs of the Torrey Club.

The second paper was by Professor Francis E. Lloyd, on 'The Nucleus in Certain Myxo-

mycetes and Schizophyceæ.' Mr. Lloyd remarked that the work of Strasburger (1884), and later of Lister, gives evidence that the nucleus of the Myxomycetes is a definite organ possessed of a nuclear membrane and containing chromatin. During cell-division the chromatin is segregated into rounded masses lying in the nuclear plate. A spindle is formed. After the formation of a fine nuclear membrane the spindle fibres gradually disappear. The small number of these parallel fibres and absence of a cell plate led Strasburger to compare the nucleus to the animal rather than the plant type. Precisely similar conditions are, however, found in some plant cells.

The presence of a nucleus in the Schizophyta has been a point of controversy. Bütschli asserts the nuclear character of the central body, and regards the red granules as chromatin. A. Fischer denies the accuracy of the former's conclusions, the question remaining an open one. When our knowledge is complete it is highly probable that the nucleus will be found to be of the distributed type, of a type, therefore, comparable to that of the simpler protozoa. In any case the nucleus of the lowly plants is much more primitive than that of the Myxomycetes. We are led, therefore, to regard these curious, much-debated forms, the Myxomycetes, as either plants of a higher type than the Schizophyta, which have degenerated, or as animals related probably to the sporozoa. For the former view there is now little evidence.

The Secretary addressed the Club briefly regarding the discarded species *Aster gracilentus*, T. & G., and exhibited its type specimen, which formed a sheet of the herbarium of M. A. Curtis, now at Princeton, and was exhibited through the courtesy of Professor George Macloskie, of that University.

Mr. Howe exhibited a number of examples of *Wolffia*, discovered floating in Van Cortlandt Lake, constituting the third recorded collection within New York State of this minutest of flowering plants.

Dr. Rusby exhibited a *Paulownia* blossom in which half an anther had grown on the outside of the corolla. Dr. Britton reported two interesting additions to the collections of the New York Botanic Garden: 1st, a valuable collec-

tion of photographs illustrating the cultivation of the poppy in Asia Minor; and 2d, a gift to the Garden from Mr. Peter Barr, the English horticulturist, of a collection of *Narcissus* and *Pæonia* for planting in the Botanic Garden. The claim of free entry as museum material was at first refused by the New York custom house; but, after five different appeals, the final decision was that the material was proper to an outdoor museum, and free entry was granted.

EDWARD S. BURGESS,
Secretary.

DISCUSSION AND CORRESPONDENCE.

THE PUMAS OF THE WESTERN UNITED STATES.

A RECENT examination of Rafinesque's description of *Felis Oregonensis* (*Atlantic Journal*, Vol. 1, No. 2, page 62, summer of 1832) brings up an interesting question as to the relationship of this name and those recently proposed by Dr. C. Hart Merriam for the Pumas of our Western States.

Rafinesque in the above article describes two species. The second of these is *Felis macroura*, based on an account in Léray's Travels, of an animal resembling the Conguar of the Alleghanies, but not larger than a cat, 'with tail as long as the body, which is from one to two feet long only.' The source of this information is unreliable and the probability is that no such animal existed.

The first species described is, however, of more importance. Rafinesque's description is as follows:

"1. Var. *Oregonensis*. Dark brown, nearly black on the back, belly white; body six feet long, three high, tail two or three feet long. A large and ferocious animal of the mountains. Is it not a peculiar species? *Felix* [sic] *oregonensis*."

In the introductory paragraph of the article he says: "In addition to the article on our Couguars, page 19, I have to state that several other varieties of tygers are found in the western wilds of the Oregon mountains, or east and west of them, which deserve to be noticed. I find in my notes that two other varieties of Couguar have been seen there east of the mountains."

The *Felis macroura*, he states distinctly,

dwells on the plains east of the Oregon mountains, but no definite locality is given under the description of *F. oregonensis*.

The indefiniteness of the opening paragraph where the forms are stated to occur, both east and west of the mountains, makes this name apparently applicable to either the Puma of the Rocky Mountains or the Northwest coast region. However, the fact that the other species (*macroura*) is said to occur east of the mountains, gives this form the benefit of whatever the use of the word 'west' was intended to imply, and, furthermore, the dark color which is distinctly pointed out would seem to fix the name *oregonensis* on the Northwest coast form.*

Dr. Merriam, in Proceedings of the Biological Society of Washington, July 15, 1897, p. 219-220, proposed the name *Felis hippolestes* for the Puma of the Rocky Mountains, and *Felis hippolestes olympus* for the Northwest coast form, apparently overlooking the paper by Rafinesque.

In view of the evidence here set forth, it seems that Rafinesque's name must be recognized, and I would, therefore, suggest that the proper names for the two animals should be

Felis oregonensis (Raf.) Northwest Coast Puma.

Felis oregonensis hippolestes (Merr.) Rocky Mountain Puma.

WITMER STONE.

ACADEMY OF NATURAL SCIENCES,
PHILADELPHIA, December 9, 1898.

THE SCHMIDT-DICKERT MOON MODEL.

THE installation of the Schmidt-Dickert relief model of the moon in a scientific institution deserves, perhaps, a passing notice. This seems the more desirable since in so generally accurate a work as 'Webb's Celestial Objects for Common Telescopes,' edition of 1896, the statement is made that this model is in Bonn. It has not been in Bonn for fully twenty years, and for most of that time has been in this country.

While occasionally exhibitions have been made of the model during this time they have been of short duration and in different cities, so that, for this time at least, it has been practically lost to the world. Through the generosity of

*'Oregon' of this date, of course, included the present State of Washington and much of British Columbia.

Mr. Lewis Reese, a citizen of Chicago, the model has now come into the possession of the Field Columbian Museum and has lately been installed in this institution. It is now, therefore, freely available for purposes of study and instruction. Since it has been so long lost from view some facts regarding the model may be of interest. It was constructed in 1854 by Th. Dickert, Curator of the National History Museum in Bonn, under the direction and with the cooperation of Dr. J. F. Julius Schmidt. The name of the latter is of itself sufficient guarantee of the accuracy and perfection of detail exhibited by the model, especially as Dr. Schmidt states that he tested with his own hand the accuracy of nearly all the measurements. So much labor was necessary in order to insure accuracy in the details that the work of modeling and construction occupied five years. The model is in the form of a hemisphere, 18 Paris feet (19.2 English feet), in diameter. Its horizontal scale bears the ratio to that of the moon of 1:600,000, the vertical 1:200,000. It is made up of 116 sections, each 15 degrees in length by 15 degrees in breadth. The consecutively joined edges of these sections serve to mark upon the surface of the model, parallels and meridians. The different colors exhibited by different parts of the moon are also depicted upon the model, the prevailing color being a dull yellow, broken by gray-green where the 'seas' occur, and by representations in lighter yellow of the bright streaks which radiate so prominently from some of the craters. The orientation which has been adopted for the model is the normal one of the moon, not inverted as it is when seen through an astronomical telescope. The north pole of the hemisphere is therefore above, the south pole below; east is to the left, and west to the right. The surface details of relief shown upon the model are based upon the charts of Beer and Madler, but many new localities were added from the observations of Dr. Schmidt himself. In all over 20,000 distinct localities are represented, modelled proportionally according to the relief which they present upon the moon. One may, therefore, study the relief with the greatest confidence that the actual topography of the moon is represented, and is spared the confusion arising

from the varying effects of shadows which make the study of the moon itself possible only to specialists. With the advance which has taken place in the interpretation of topographic forms in the last twenty years, it seems not too much to hope, now that this model has been made accessible to students of science, that its study will bring to light new facts regarding the nature and history of our satellite..

OLIVER C. FARRINGTON.

FIELD COLUMBIAN MUSEUM, CHICAGO.

LEHMANN AND HANSEN ON 'THE TELEPATHIC PROBLEM.'

TO THE EDITOR OF SCIENCE: I can assure Professor James that I do not knowingly leave unread anything that he or Professor Sidgwick writes. I carefully considered the two papers to which he refers, at the time of their appearance, and have recently turned to them again. I am afraid, however, that I cannot make the admission that Professor James expects. Even if I granted all the contentions of criticism and report I should still see no reason to change the wording of my reference to Lehmann and Hansen. But there is a great deal that I cannot grant. While, like Stevenson's Silver, 'I wouldn't set no limits to what a virtuous character might consider argument,' I must confess that, in the present instance, the grounds for such consideration have not seldom escaped me.

Professor James rules that the *Phil. Studien* article is 'exploded.' I have tried to take up the position of an impartial onlooker; and, from that position, I have seen Professor James and Professor Sidgwick and Herr Parish handling the fuse, but I have not yet heard the detonation.

E. B. TITCHENER.

ASTRONOMICAL NOTES.

THE NOVEMBER METEORS.

REPORTS of meteor observations made this year between the 11th and 16th have been published from England, France and the United States. These are sufficient to show the characteristics of the display and to furnish hints as to the methods which should be followed in future years. The greatest number of meteors was noted on the morning of the

15th (civil reckoning), when the rate reached two each minute at some stations in the United States. A single observer could count forty or more per hour. It is probable that the maximum had already passed, as more meteors were noted on the preceding than on the following night at the few stations where the skies were clear on those nights. On the 14th a single observer at Lyons, France, noted 134 between 1:04 a. m. and 4:05 a. m. On account of the cloudy weather at Paris M. Janssen made a balloon ascension and observed above the clouds. We are told that this plan of securing clear skies will be used more extensively next year. The number observed this year is fully ten times as great as those observed in 1897 and is about the same as that noted at Greenwich in 1865, the year preceding the great shower of 1866. This augurs well for the year 1899.

Observers report several interesting facts: (1) Many meteors with the characteristics of the Leonids did not proceed from the radiant area within the 'Sickle of Leo.' The discrepancies in locating the radiant point are not to be wholly explained by the errors to which all eye estimates of meteor tracks are liable, but are in part real. (2) The radiant area has for its center a point which is farther south than that calculated from the observations of 1866, which was R. A. 10 h. 0 min., Decl. + 22°.9. The records this year, as far as known, range between 9 h. 50 min. and 10 h. 20 min. in R. A. and + 18° to 22° in Decl. A preliminary determination from the photographed trails of four meteors made at Harvard Observatory gives 10 h. 6.8 min., Decl. + 22°16'. (3) There were very few brilliant meteors compared with the total number. At Providence fourteen only out of nearly five hundred were brighter than the first magnitude.

The practicability of the photographic method of studying meteors needed no demonstration, but its possibilities are greater than was supposed. An ordinary camera, such as those in use by amateurs, will photograph the brighter meteors. Thus one with an aperture of only one inch and focal length of nine inches, if carefully focussed, will give trails of meteors as bright as the 0 magnitude. The camera need

not be driven by clockwork if the time of the appearance of the brightest meteors in the region towards which the camera is directed is noted. For then the exact positions of the comparison stars in their curved trails while the plate is exposed is known. Amateur assistance in meteor photography is, therefore, valuable. Of still greater value is the photographic record by the larger instruments. Not only can the paths of the meteors be located with accuracy and the position of the radiant points determined, but special characteristics of the trails may be studied. Thus the Harvard Circular, No. 35, mentions that the light attained a maximum and then diminished as rapidly as it increased; that sudden changes due to explosions are well shown; that the trail is sometimes surrounded by a sheath of light, and that in one case the trail remained after the meteor had passed. That these characteristics, which have been noted visually heretofore, should now submit to a permanent photographic record shows that photography will have a large place in this branch of astronomical study.

CHASE'S COMET (J. 1898).

THE discovery of this comet on the plates exposed at New Haven, on the radiant region of the Leonids, is the most interesting episode of the meteor observations. The photographic brightness was estimated to be equal to a star of the 11th magnitude, but it was much fainter in a visual telescope. It was hoped that it might be connected with the meteor stream, but its orbit shows that it simply chanced to be in that direction when observed. The preliminary orbits thus far published are unusually discordant, perhaps due to the combination of the photographic and visual determinations of position.

STELLAR MOTIONS.

PROFESSOR W. W. CAMPBELL, of the Lick Observatory, in the publications of the Astronomical Society of the Pacific, announces the rapid movement towards us of two stars, η Cephei and ζ Herculis. From four photographs of their spectra he determines a relative velocity of 53.9 miles per second for the former and 48.7 for the latter. Allowing for the motion of the solar system, these figures are reduced to 46.0 miles

per second and 33.5 miles per second respectively.

WINSLOW UPTON.

BROWN UNIVERSITY,
December 16, 1898.

CURRENT NOTES ON ANTHROPOLOGY.

THE AMERICAN HERO-MYTH.

Two studies have lately appeared on the widely diffused myth of the 'culture-hero' in America. The one is by the Count de Charencey, on the legend of Huitzilopochtli, printed in the *Proceedings* of the French Association for the Advancement of Science, 1897; the other is by Dr. Franz Boas, reprinted from the *Memoirs* of the American Folk-lore Society, Vol. VI., and treats of the Salish Raven Myth and others from the Northwestern tribes.

All these myths are strikingly alike in many details, and both these writers agree that 'it is inconceivable that they originated independently.' Hence Dr. Boas claims that the various raven and coyote tales have a common source; and with precisely the same and equally strong arguments M. de Charencey shows that the myths of the Mayas and Nahuas originated in eastern Asia.

To my thinking, not the similarities (for these we should expect from the constitution of the human mind), but the differences in such myths are what should command our chief attention.

THE PRIMITIVE SAVAGE.

'Was primitive man a modern savage?' is the question asked by Dr. Talcott Williams in the Smithsonian Report, just issued, and answered by him in a constructive negative. To Dr. Williams, primitive man was a peaceful, happy creature, knowing not war or cannibalism, with a 'surprising primitive development,' which later on degenerated into civilization. This early man enjoyed 'a juster conception of the divine' than his descendants. His gods were peaceful, communication free, hospitality open. "The earth was still empty and happy and young."

If Dr. Williams intends this as a pleasant, humorous sketch, it will pass; if a serious inference from the ascertained facts of prehistoric

investigation, its author is about a century behind time, as every student of the actual remains of earliest man knows the painful but irrefutable evidence of his worse than barbarous, his really brutal, condition, apart from all comparisons with modern savages.

A BOOKLET ON ETHNOLOGY.

DR. MICHAEL HABERLANDT is a 'Privatdozent' in the University of Vienna and also Curator of the Ethnographic Collection in the Royal Museum of that city. A few months ago there appeared from his pen a duodecimo treatise on Ethnography which offers much the best summary of the science which I have anywhere seen. Of its 200 pages half are devoted to general principles, those which belong to 'Ethnology;' and the remainder to descriptive ethnography. Both are characterized by thorough familiarity with the facts, and careful, independent reflection on them. The introduction discusses, with remarkable clearness, the principles of social degeneration and evolution.

Just such brief, clear, up-to-date books as this are what we need in anthropology in this country. It is better to write them than to translate them, and it is unfortunate that we still lack them. (*Völkerkunde*, G. F. Goschen, Leipzig. 1898.)

D. G. BRINTON.

UNIVERSITY OF PENNSYLVANIA.

SCIENTIFIC NOTES AND NEWS.

IN the present issue of *SCIENCE*—which opens a new volume—the short notes are placed at the end, in the part of the number which is the last to be printed. These notes should contain reliable, prompt and full information, and men of science in America and abroad are requested to contribute items of news whose publication will forward the objects of this JOURNAL.

THE Paris Academy of Sciences has awarded its Lalande prize to Dr. S. C. Chandler, of Cambridge, Mass., and the Damoiseau prize to Dr. George W. Hill, of Columbia University.

PROFESSOR G. W. FARLOW, of Harvard University, has been elected President of the American Society of Naturalists. Professor H. C. Bumpus, of Brown University, to whom the recent growth and successful meetings of the

Society have been in large measure due, has resigned the Secretaryship and is succeeded by Professor T. H. Morgan, of Bryn Mawr College.

PROFESSOR R. S. WOODWARD, of Columbia University, has been elected President of the American Mathematical Society in succession to Professor Simon Newcomb.

PROFESSOR JOHN DEWEY, of the University of Chicago, has been elected President of the American Psychological Association.

THE office of Mr. W. T. Hornaday, Director of the New York Zoological Park, has been moved from 69 Wall Street to the Park, Southern Boulevard and 183d Street, and communications should now be sent to this address. The offices are temporarily established in the Elk House, near the southwest corner of the Park.

THE Rev. Dr. Bartholomew Price, Master of Pembroke College, Oxford, and until last year Sedleian professor of natural philosophy, died on December 29th in his 81st year. He was the author of works on dynamics and on the calculus.

DR. JOHN B. HAMILTON, formerly Surgeon-General of the U. S. Marine Hospital Service, editor of the *Journal of the American Medical Association* and professor of surgery at the Rush Medical College, Chicago, died at Elgin, Ill., on December 24th.

DR. WILLIAM MUNK, the well-known London physician, died on December 20th, aged 73. He was formerly Librarian of the Harveian Library of the Royal College of Physicians and author of the Roll of the College and other works, both of a biographical character and on medical subjects.

THE New York Section of the American Chemical Society was able to receive the Society at its recent New York meeting in the Chemists' Club, newly established in the building at 108 West 55th Street. The club-house contains a large assembly room for meetings, smaller rooms and accommodation for the library, which it is expected will be deposited there. The President of the Club is Professor Charles F. Chandler, of Columbia University.

THE Royal Institution, London, was founded

in 1799 and will this year celebrate its centenary by special exercises, the character of which has not yet been announced.

THE Boston Medical Committee has awarded its prize to Dr. Guy Hinsdale, of Philadelphia, for an essay on Acromegaly, which has just been published. For 1900 two prizes are offered by the Committee: (1) A prize of one hundred and fifty dollars for the best dissertation on 'The Results of Original Work in Anatomy, Physiology or Pathology,' the subject to be chosen by the writer. (2) A prize of one hundred and fifty dollars for the best dissertation on 'The Method of Origin of Serpentine Arteries and the Structural Changes to be found in them; Their Relation to Arteria-capillary Fibrosis, Obliterating Endarteritis and to Endarteritis Deformans.' Dissertations on these subjects must be sent on or before January 1, 1900, to the Secretary of the Committee, Dr. W. F. Whitney, Harvard Medical School, Boston, Mass.

THE Paris Academy of Medicine has held its annual public meeting for 1898 and awarded the large number of prizes at its disposal. No less than forty prizes were given, not including a large number of medals.

DR. NOLAN has presented to the Philadelphia Academy of Natural Sciences, as a memorial of the late Dr. Joseph Leidy, five volumes of biographical notices, portraits, autograph letters and original drawings. The first volume contains several addresses and articles prepared on the occasion of Dr. Leidy's death and other interesting biographical material. The second volume contains botanical drawings and notes and the remaining three volumes zoological drawings and notes. The volumes are carefully indexed.

At the next meeting of the British Medical Association, which will be held at Portsmouth from the 1st to the 4th of August, the address in medicine will be given by Sir Richard Powell and the address in surgery by Professor Alexander Ogston.

AMONG those who will give Friday evening discourses before the Royal Institution, London, during the present season are Lord Rayleigh, Professor H. L. Callendar, Mr. Victor Horsley,

Professor H. S. Hele-Shaw and Professor Dewar, who will give the first lecture on January 20th, on Liquid Hydrogen.

THE English papers contain details of the meeting to further the objects of the National Association for the Prevention of Consumption, held at Marlborough House on December 20th. The Prince of Wales presided, and addresses were made by Sir William Broadbent, Sir Granger Stewart, President of the British Medical Association, Dr. Moore, President of the Royal College of Physicians of Ireland, Sir James Sawyer, Dr. Andrew, President of the Royal College of Physicians of Edinburgh, and Professor McFadyean. The Marquis of Salisbury moved the following resolution: "This meeting desires to express its approval of the effort which is being made by 'The National Association for the Prevention of Consumption and other Forms of Tuberculosis' to check the spread of the diseases due to tubercle, and to promote the recovery of those suffering from consumption and tuberculous disease generally. It also commends the method adopted by the Association of instructing public opinion and stimulating public interest rather than the advocacy of measures of compulsion." This resolution was seconded by Sir Samuel Wilkes, President of the Royal College of Physicians, and carried unanimously. Remarks were made by Lord Rosebery, Mr. Walter Long, M. P., and the Prince of Wales. It was announced that the London partners of Werner, Beit & Co. had contributed £20,000 for the erection of a sanitarium to be administered by the Association.

ACCORDING to cablegrams to the London *Times*, Colonel Lawrie, Plague Commissioner in Haidarabad, gave evidence on December 19th before the Plague Commission. He stated that the first indigenous case occurred in January, 1897. The measures adopted were evacuation, disinfection, and the burning of floors and walls in kilns. Haffkine's fluid was not a serum, but a putrescent organic liquid containing micrococci of putrefaction and occasionally pathogenic organisms. It was, therefore, directly against modern medicine and antiseptic surgery to inject the fluid. Inoculation had not been

adopted. The burning process was found satisfactory as a means of destroying the plague. Mr. Stevens, Deputy-Commissioner, said that 68 villages in Haidarabad territory had been attacked during 1898. Disinfection by burning in kilns had absolutely destroyed all germs. No bacteria were found in the ashes; the plague never reappeared, and the villages were completely disinfected by the kilns. The plague fugitives were sent back in charge of the police. The classes most affected were low-caste Hindus. Mohammedans were not so liable to infection, nor were the herdsmen, who lived in the open air. Age and sex made no apparent difference. Captain Johnson, on December 20th, described experiments which had been made to determine whether living organisms were found in Haffkine's fluid. Out of six bottles five showed a distinct growth; the other was doubtful. Mazhar Husain, a native practitioner, stated that in the villages in the Naldrug district corpses and their appendages were burnt where such a course was not forbidden by religion; in other cases the dead bodies were buried eight feet deep. The kiln process was adopted with all houses irrespective of individual infection. After the evacuation the fall in mortality was striking. The villages were re-occupied two months after the cessation of deaths. No case occurred among infants. Fair success was obtained by treatment with red iodide of mercury pills. Colonel Lawrie, recalled, expressed his willingness to use Haffkine's fluid if it were rendered sterile, provided it was proved to retain its prophylactic power under those conditions. He admitted that the fluid as now used afforded considerable protection, but denied that it gave immunity. Sterilization, he thought, might render it useless. The plague returns for the second week in December showed a further rise for Bombay city and district, and also for Madras and the Central Provinces. There was a considerable fall in the returns from Mysore.

UNIVERSITY AND EDUCATIONAL NEWS.

In addition to the million dollars given by Lord Strathcona for the endowment of the Royal Victoria College for Women, McGill Uni-

versity and the endowment of a chair of history by Sir William MacDonald, already announced in this JOURNAL, we are informed that at the same time Lady Strathcona and the Hon. Mrs. Howard each gave \$50,000 for the Faculty of Medicine and that the Board of Governors of the University gave \$200,000 for general endowment.

At a recent conference on secondary education convened by Victoria University at Owens College, Manchester, on December 3d, a resolution was passed recommending that the education department should be represented by a Minister of Education of Cabinet rank.

GOVERNOR ROOSEVELT will, it is understood, serve actively on the Board of Regents of the University of the State of New York, of which he is *ex-officio* a member, and will accept the Chairmanship of the Committee on the State Library. Recent Governors of the State have neglected this duty.

At Trinity College, Cambridge, the Coutts Trotter studentship of the value of £250 for the promotion of original research in natural science, open to graduates of the College not being Fellows, has been divided between H. H. Dale, B.A. (zoology and physiology), and the Hon. R. J. Strutt, B.A. (physics), both scholars of the College.

DR. EUGEN DUBOIS has been called to a professorship in geology in the University of Amsterdam. Dr. Kippenberger has been appointed professor of chemistry in the University of Breslau. Dr. Wagner has qualified as docent in physical chemistry in the University of Leipzig and Dr. Weinschenk in mineralogy and geology in the Polytechnic Institute at Munich. In the University of Paris, M. Vidal de la Blache has been appointed professor of geography and M. Seailles has been made professor of philosophy. M. Lacour has been made associate professor in the Faculty of Science at Nancy. In University College, London, Mr. W. G. Savage has been appointed as assistant in the department of bacteriology and Mr. G. Bertram Hunt, M.D., has been appointed assistant in the department of pathological histology.

SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IBA REMSEN, Chemistry; J. LE CONTE, Geology; W. M. DAVIS, Physiography; O. C. MARSH, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; HENRY F. OSBORN, General Biology; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; J. MCKEEN CATTELL, Psychology; DANIEL G. BRINTON, J. W. POWELL, Anthropology.

FRIDAY, JANUARY 13, 1899.

OUR SOCIETY.*

CONTENTS:

<i>Our Society</i> : PROFESSOR J. J. STEVENSON.....	41
<i>Fishes of the South Shore of Long Island</i> : DR. TABLETON H. BEAN.....	52
<i>Suppression of Smoke</i> : PROFESSOR R. H. THURSTON.....	55
<i>American Mathematical Society</i> : PROFESSOR F. N. COLE.....	57
<i>General Meeting of the American Chemical Society</i> : DR. DURAND WOODMAN.....	58
<i>Scientific Books</i> :—	
<i>Cayley's Collected Mathematical Papers</i> : PROFESSOR GEORGE BRUCE HALSTED. <i>Allen's Commercial Organic Analysis</i> : PROFESSOR W. A. NOYES. <i>Folwell on Sewerage</i> : M. M. <i>Hill on Cuba and Porto Rico</i> : W. J. M. <i>Butler on the Birds of Indiana</i> : F. M. C. <i>Holland's Butterfly Book</i> : PROFESSOR S. H. SCUDDER. <i>Books received</i>	59
<i>Scientific Journals and Articles</i>	67
<i>Societies and Academies</i> :—	
<i>The Philadelphia Academy of Natural Sciences</i> : DR. EDW. J. NOLAN.....	68
<i>Discussion and Correspondence</i> :—	
<i>The Sensation of Motion and its Reversal</i> : PROFESSOR W. S. FRANKLIN. <i>Occurrence of the Virginia Opossum in Southern Central New York</i> : J. ALDEN LORING.....	70
<i>Notes on Inorganic Chemistry</i> : J. L. H.....	71
<i>Current Notes on Meteorology</i> :—	
<i>Climate and Hygiene of the Congo Free State</i> ; <i>A New Mountain Aneroid Barometer</i> : R. DEC. WAED.....	72
<i>Zoological Notes</i> :—	
<i>The New York Zoological Park</i> : F. A. L. <i>The Statistical Method in Zoology</i> : H. C. B.....	73
<i>Botanical Notes</i> :—	
<i>A Botanical Almanac</i> ; <i>Check List of Forest Trees</i> ; <i>Cretaceous and Tertiary Plants</i> ; <i>Lewis and Clark's Plants</i> : PROFESSOR CHARLES E. BESSEY.....	74
<i>Current Notes on Anthropology</i> :—	
<i>Arrow Feathering in South America</i> ; <i>A Study of the Lips</i> ; <i>Physiology of Criminals</i> : PROFESSOR D. G. BRINTON.....	76
<i>Scientific Notes and News</i> :—	
<i>The Endowment of the Jenner Institute</i> . <i>General University and Educational News</i>	78
	80

SEVERAL travellers of the eighteenth century, among them especially Guettard, Alexander and Schoepf, gave more or less important information respecting the geological structure and mineral resources of our country; but geological work, properly so-called, began only with Maclure's studies in 1806. Born in Scotland, Maclure came to this country in early youth and, embarking in business, acquired a fortune long before reaching middle age. He returned to Europe to spend several years in the study of natural science, but came again to America in 1806 to take up his geological work, which continued until 1808.

The publication of his results, presented to the American Philosophical Society on January 20, 1809, led others to make studies and soon afterwards there appeared numerous papers dealing with geological subjects. Professor Samuel L. Mitchell, a devoted follower of Werner, infused much of his enthusiasm into a group of youthful students in New York and induced Professor Archibald Bruce to establish the *American Journal of Mineralogy*, which, beginning in 1810, reached its fourth and last number in February, 1814. Though small and short-lived, this journal served a useful purpose; it contained good papers by

* Presidential address delivered at the annual meeting of the Geological Society of America, New York, December 28, 1898.

Akerly, Gibbs, Godon, Mitchell, Silliman and others; it did much to nurse the scientific tendency which led to founding the New York Lyceum of Natural History in 1817, and some have thought that it aided in like manner the founding of the Philadelphia Academy in 1812. *Bruce's Journal* was succeeded in 1818 by *Silliman's American Journal of Science*, which from the beginning exerted a notable influence upon the development of geological thought and work in our country.

By 1820 students of geology had become so numerous that the American Geological Society was organized in New Haven, Connecticut, where meetings were held certainly until the end of 1828. The last survivor of this Society died in New Haven only a few weeks before the formal organization of our Society in 1888. The prominent men in 1820 were Akerly, Bruce, Cornelius, Cleveland, the two Danas, Dewey, Eaton, Gibbs, Godon, Hitchcock, Maclure, Mitchell, Rafinesque, Schoolcraft, Silliman and Steinhauer, but there were some young men who began to publish within two or three years afterwards and who were destined to occupy prominent places in geological literature; of these, Emmons, Harlan, Lea, Morton, Troost and Vanuxem were already engaged in investigation.

Before another decade had passed there were groups of geologists in New England, New York and Pennsylvania, while Olmstead and Vanuxem had made preliminary surveys in North Carolina and South Carolina. Troost had begun the survey of Tennessee and Hitchcock that of Massachusetts.

In 1832 the Pennsylvania geologists, feeling much in need of an official survey of their State, organized the Geological Society of Pennsylvania, to arouse public interest and so to bring about the survey. The volume of publications contains papers which attack geological and economic prob-

lems of the first order. The investigations were not confined to Pennsylvania, but committees were appointed to examine important matters in other States, that the worth of geological work might be made obvious. Beyond doubt, the efforts of this Society had much to do with securing the First Geological Survey of Pennsylvania, though no member of the Society was appointed on the staff. It is the fashion now and then to laugh at these old papers. True enough, in the light of our present knowledge, many of the statements respecting Appalachian structure are absurd, but they were made by men who, without State aid, without instruments and without maps, laid a foundation upon which the keen-eyed men of the First Pennsylvania Survey built the superstructure, which endured close re-examination by the second survey and proved the honesty and ability with which the work had been performed.

But geology was becoming too broad in scope and its workers too numerous to be embraced in a merely local society, even though the list of correspondents was as large as that of the active members. The work in Massachusetts was approaching completion; that in New Jersey had been completed; the Surveys of Maine, Connecticut, New York, Pennsylvania, Maryland, Delaware, Virginia, Ohio, Michigan and Indiana had been begun, and before 1840 New Brunswick, Rhode Island and Kentucky were added to the list. Several of these Surveys had large corps of workers, pushing their studies with all the enthusiasm of a new calling. In the Appalachian region of Massachusetts, New York, Pennsylvania and Virginia serious problems were encountered which could not be solved within the compass of a single State. A right understanding of the work done in one State was necessary to a right understanding of the work done in the adjoining State. Correspondence proved a failure;

incidental or casual talks led to misunderstandings; systematic conference was necessary with generous contribution by each of his knowledge to the other.

On April 2, 1840, as the result of a conference held at Albany in 1839, eighteen geologists met at the Franklin Institute, Philadelphia, and organized the Association of American Geologists, with Professor Edward Hitchcock as the first Chairman; among these were the State Geologist of Massachusetts, six geologists of the New York Survey, six of the Pennsylvania Survey, two of the Michigan and three not connected with any public work. Mr. Martin H. Boye is the only survivor of the eighteen. The succeeding meetings in Philadelphia and Boston were attended by many geologists, of whom only Boye, O. P. Hubbard and J. P. Lesley remain. A volume published in 1843 contains several papers which made a deep impress on American geology; here are the five great memoirs on Appalachian conditions by the Rogers brothers; Hall's noteworthy discussion of the Mississippi basin section; Hitchcock's elaborate discussion of the 'Drift;' as well as numerous contributions by other members.

Professor Hall said on one occasion that the inspiriting effect of these meetings could not be overestimated. As one of the youngest members, he was impressed by the mental power of those great men, all untrained in geology, except Taylor, whose training under William Smith proved advantageous in many ways but very disadvantageous in others, as it had provided him with a generous stock of well-set opinions. Though wholly self-taught, working in a country sparsely settled, without barometers, without railroad cuts, oil borings, mine shafts or any of the advantages so necessary for us, those men had elaborated systems, had made broad generalizations, had learned much respecting the succession of life and had discovered the keys which,

in later years, were to open mysterious recesses in European geology.

But the geologists were not permitted to flock by themselves. The advantages of contact were so manifest that the naturalists asserted their claims to relationship with sufficient energy to secure admission in 1841, and the name Association of American Geologists and Naturalists appeared in the constitution adopted at the 1842 meeting. The number of scientific men was still comparatively small, and in most of the colleges the several branches of natural science were embraced in one chair, so that there were many professors who could lay claim to the title of geologist, physicist, naturalist or chemist, as they pleased. Men of this type, as well as physicists, chemists and mathematicians, constantly urged the propriety of broadening the scope of the Association so as to admit workers in all branches of science.

In 1842 the first series of surveys practically came to an end, and the geologists were scattered, many of the younger men being compelled to enter other callings. The Association held its meetings regularly, but its strength diminished, and in 1848 it yielded to the outside pressure, becoming merged into the American Association for the Advancement of Science, which threw its doors wide open to all entertaining an interest in any branch of science. The first meeting of the new organization had a roll of 461 members.

Comparatively little was done in geological work between 1842 and the close of the Civil War. Professor Hall maintained the New York Survey, after a fashion, but at very considerable pecuniary cost to himself; surveys were carried on in a number of States, but, except in Illinois and California, they were mostly reconnaissances by small corps; the annual appropriations in several instances were little more than enough to pay travelling expenses, so that

the work and the reports were practically gifts to the States. The Federal Government sent topographic expeditions into the Western country, most of them accompanied by a surgeon who had more or less knowledge of geology. Under such conditions the number of geologists did not increase, and when the American Association was divided into sections, in 1875, the geologists and naturalists became not Section A, but Section B.

The rapid development of the country's internal resources during the war and the attendant growth in manufacturing interests made necessary increased efficiency in scientific training, and enormous gifts were made to our leading institutions for that purpose. The importance of geological knowledge had become very evident during the development of iron, coal and oil resources, and the geologist found himself elevated suddenly from a place surrounded by suspicion to a post of honor. As an outgrowth of the restless activity due to the war came anxiety to learn more accurately the resources of our Western domain beyond the 100th meridian. The War Department, through its Engineer Corps, organized the Fortieth Parallel Survey, in charge of Clarence King, and two years afterwards authorized Lieutenant (now Major) George M. Wheeler to undertake what afterwards became the United States Geographical Surveys West of the 100th Meridian. Mr. King's survey was primarily for geological work, that of Lieutenant Wheeler primarily for topographical work, but each in its own field did all the work, geological or topographical, necessary to the accomplishment of the allotted task. The Interior Department had charge of Dr. F. V. Hayden's surveys, beginning in 1867, as well as of the work prosecuted by Major J. W. Powell after 1870. The consolidation, in 1879, of all the organizations then existing put an end to useless rivalries

and made possible the formation and execution of broad plans requiring a high grade of preparation in those engaged upon the work. But while these surveys were advancing in the Far West great activity prevailed in the older area. Within a decade after the war ended State Surveys were undertaken in New Hampshire, New Jersey, Pennsylvania, Ohio, Indiana, Kentucky, Michigan, Wisconsin, Minnesota, Iowa, Missouri and other States, while the Canadian Survey, which had gone on uninterruptedly from the early forties, was made more extended in character. Several of the State Surveys, being well supported by generous appropriations, employed large corps of assistants, paid and volunteer, and were prosecuted with great energy. Under these conditions Section E, that of Geology and Geography, grew rapidly and soon became one of the strongest portions of the American Association.

The conditions which rendered imperative an association of geologists in 1840 were the present conditions in 1880, but more oppressive. The problems of 1840 were chiefly those of a narrow strip within the Appalachian area; those of 1880 concerned the whole continent. Geologists were increasing in numbers, but opportunities for making personal acquaintance were few; meetings of societies in midsummer could be attended only by those who were not connected with official surveys or were detached for office work. Workers were gathering into little groups on geographical lines, and there was danger that our geology would become provincialized. Members of one group regarded those of another with a feeling not altogether unrelated to suspicion; letter-writing took the place of personal communication, with too often the not-unusual result of complete misunderstanding, with the attendant personal irritation or worse.

In 1881 the tension was such that several

geologists connected with official surveys urged the formation of a geological society to bring about closer bonds among geologists; and they succeeded, at the meeting of the American Association, in securing the appointment of a committee to consider the matter. The geologists of the country were consulted, and a report, showing that the consensus of the replies favored the organization of such a society, was presented in 1882 as well as in 1883, but without any result. The Association's Committee on the International Geological Congress considered the question in 1887 and announced approval. Professors N. H. Winchell and C. H. Hitchcock, as Chairman and Secretary of the 1881 Committee, issued a call asking geologists to assemble at Cleveland, Ohio, on August 14, 1888, to form a Geological Society.

A large number of geologists and other members of Section E assembled on the afternoon of that day. Professor Alex. Winchell presided and Dr. Julius Pohlman was Secretary. An earnest discussion respecting the type of society to be founded occupied most of the afternoon. The plan suggested in the call looked only to an expansion of Section E of the American Association by holding meetings at times better suited than summer to the convenience of geologists. But a difference of opinion quickly developed, for some knew that no such expedient would suffice, that the conditions called for something more definite. Loyalty to the American Association, which for forty years had been the bond between scientific men, held many back from an extreme position. Yet every one recognized that little injury could come to the Association, as, at best, only a few geologists could attend summer meetings. In any event, it was clear that the interests of geology required the formation of a society with severe restrictions upon membership and with publications which would

be a credit to American science. A compromise prevailed, whereby the Original members, entitled to take part in organization, must be members of Section E of the American Association, and that all members of Section E might enroll prior to the first meeting if they so desired. This last provision caused not a little anxiety, as membership in any section of the Association predicates nothing more than a friendly feeling for science—whatever that may mean.

A committee* was appointed to prepare a plan of organization with a provisional constitution. The committee's report, on the morning of the 15th, provoked debate, as the provisional constitution placed a positive limit upon the membership by permitting, after the organization, only working geologists and teachers of geology to become members and by requiring a three-fourths vote for election. The organization was to be effected when the list of Original members contained one hundred names. The provisional constitution, with a few unimportant amendments, was agreed to unanimously and a committee continued as a committee of organization. The details of arrangements were placed in the hands of Professors A. Winchell and Stevenson.

Happily the high dues and general belief that no society could be formed on the proposed basis kept the list of Original Fellows from being swollen by those whose relation to geology began and ended with attendance upon the American Association's meetings. The committee was enabled from the very outset practically to choose the men who should make the society. The required number having been obtained by the 1st of December, a meeting was held at Ithaca, New York, on December 27, 1888. Only thirteen were pres-

* This committee consisted of Alexander Winchell, J. J. Stevenson, C. H. Hitchcock, John R. Procter and Edward Orton.

ent, but ballots of preference had been received from seventy-two Fellows, in accordance with which the organization was completed by the election of President, James Hall; Vice-Presidents, James D. Dana and Alexander Winchell; Secretary, John J. Stevenson; Treasurer, Henry S. Williams; Councillors, John S. Newberry, John W. Powell and Charles H. Hitchcock.

The matter of publication was discussed at great length, but no definite decision could be reached, and a committee was appointed to consider the whole question, with instructions to present a report at the summer meeting. Another committee was appointed to prepare a permanent constitution, to be presented at the next meeting.

The Advisory Committee on Publication, another name for Professor W J McGee, made an elaborate investigation of the whole question of publication and, in August at Toronto, presented the report, accompanied by a printed example of the form recommended. This report was adopted and, at the close of the following meeting, Dr. McGee was chosen as first Editor that the recommendations might be carried out faithfully. Our Bulletin, which marked a new stage in scientific publications, owes its excellence of form and accuracy of method to his indefatigable persistence. His determination to secure exactness in all respects proved not wholly satisfactory to many of us, but, before he demitted his charge, the justice of his requirements was conceded on all sides. The discipline to which the Fellows of this Society were subjected by the first Editor has served its purpose, and editors of other scientific publications have found their labors lightened and their hands strengthened in efforts to produce similar reforms elsewhere.

Fears and misgivings abounded when it was discovered that this Society was a success from the start. The American Association for the Advancement of Science had

been the one society for so many years that attempts at differentiation seemed to be efforts to cut away the pillars of scientific order. But the fears were merely nightmare. Our Society has proved itself an efficient ally of the Association.

Our net membership at the close of the first year was 187. The new constitution placed severer restrictions upon membership by requiring a nine-tenths vote for election, the ballot being by correspondence and shared in by all the Fellows. This has kept the number within reasonable limits, and we now have 237 Fellows, our roll including almost all of those, who, by strict construction of our constitution, are qualified for membership. Owing to the rigid administration of our affairs by Professor Fairchild and Dr. White, who have piloted us for eight years, our financial condition is satisfactory, and the income from the permanent fund now goes far toward covering the cost of administration.

Throughout, the Society has held closely to investigation; the recondite problems, those of little interest to many, of no interest to most, are those which have held the attention of our Fellows—work in pure rather than in applied sciences; there has been no trenching upon the field of the mining engineer. As a storehouse of fact and of broad, just generalization the volumes of our Bulletin are excelled by those of no similar publication.

We close our first decade justly gratified by success and full of hope for the future. Some of those who led us and gave us reputation at the beginning are no longer with us; Hall, Dana and Winchell, the first three Presidents, passed away in reverse order; Cope, Cook, Sterry-Hunt, Newberry and a few others have gone from us, but the Society retains its membership with changes unusually small, showing no ordinary degree of physical force and *esprit du corps* on the part of its Fellows. As we look back

we recognize how far this Society has been of service to us as men; in not a few instances misunderstandings have been removed and coldness or suspicion has been replaced by personal friendship. American geologists are no longer a disorderly lot of irregulars marching in awkward squads, but form a reasonably compact body, though as individuals they may owe allegiance to Canada, the United States, Mexico or Brazil. Every one of us has felt the inspiriting influence of personal contact.

But our Society has to do with the world outside of itself and outside of its immediate line of thought. It must have more to do with that world in the future if the outcome for science is to be what it should be, for the time is approaching rapidly when we must seek large sums for aid in prosecuting our work. To retain the respect of the community and to retain influence for good we must be able to justify the existence of a society devoted to investigation as distinguished from application. The question *Cui bono?* will be asked, and the answer cannot be avoided.

This is a utilitarian age—not utilitarian as understood by those who bemoan the decay of æsthetic taste; or of those who feel that in the passing of Aristotle and Seneca there has come the loss of intellectual refinement; or of those others who bewail the degeneracy of a generation which has not produced a Kant, a Newton, an Aristotle, a Laplace, a Humboldt or an Agassiz; all regarding the decadence as due to the degrading influence of material development and overpowering commercial interests.

These pessimists stand at a poor point of view, where the angle of vision is narrowed by many lateral projections. One may say, without fear of successful contradiction, that, in so far as actual knowledge is concerned, students of our day receiving graduate degrees in the more advanced universities stand on a somewhat higher plane,

each in his own group, than did the celebrated men just named. The student now reaches beyond where they ended, and still is at only the threshold; for, in most instances, years of labor are required of him before he can receive recognition as an efficient co-worker. Men towering far above their fellows and covering the whole field of knowledge will never be known again. Kant, Newton, Humboldt stand out from their fellows as sharply as lighthouses on a level shore; but there are many Kants, Newtons and Humboldts to-day. Prior to the last seventy-five years the field of actual knowledge was insignificant and a man possessing large powers of observation grasped the whole. Seventy-five years ago one man was expected to cover the whole field of natural science in an American college. Should any man pretend to-day to possess such ability he would expose himself to ridicule.

It may be true that this century has given to the world no great philosopher—that is, no great philosopher after the old pattern. But one must not forget that philosophy has to face a difficulty which was unknown in the last century. The unrestrained soaring of philosophers into the far-away regions of mysticism is no longer possible, for facts abound and the knowledge which is abroad in the land must be considered in any well constructed system. Some have maintained, if not in direct statement, certainly in effect, that study of material things unfits one for metaphysical investigation. Undoubtedly it would hamper him in some kinds of metaphysical research, as it would fetter him with a respect for actualities, but it would fit him well for other kinds. Aristotle, Kant and, in our own time, McCosh and Spencer attained to high position as philosophers and in each case possessed remarkable knowledge in respect to material things.

The assertion of lost intellectual refinement and of depraved æsthetic taste is but the wail for an abandoned cult. It is but a variation of the familiar song which has sounded down the generations. The world was going to destruction when copper ceased to be legal tender, as well as when Latin ceased to be the language of university lectures; art disappeared when men ceased idealizing and began to paint nature as it is; religion was doomed to contempt when the Bible was translated into the vulgar tongue; and the pillars of the earth were removed when the American Republic was established.

But in a proper sense this is a utilitarian age. Everywhere the feeling grows that the earth is for man, for the rich and for the poor alike; that those things only are good which benefit mankind by elevating the mental or physical conditions. Until the present century the importance of the purely intellectual side of man was overestimated by scholars, and matters connected with his material side were contemned. With our century the reaction was too great, for even educated men sneered at abstract studies as absurdities, while they thought material things alone worthy of investigation. But the balance is steadying itself, and at each oscillation the index approaches more closely to the mean between the so-called intellectual and material sides. Devotees of pure science no longer regard devotees of applied science as rather distant relations who have taken up with low-born associates.

There appears, at first glance, to be very little connection between great manufacturing interests, on one hand, and stone pecking at the roadside or the counting of striae on a fossil, on the other. Yet a geologist rarely publishes the results of a vacation study without enabling somebody else to improve his condition. About twenty years ago one of our Fellows began to give the results of

reconnaissance studies made during vacations. These concerned certain fault lines, and the notes included studies upon coal beds and other matters of economic interest involved in the faults. The coal beds were all bought up; railroads were constructed; mines were operated; towns were built; a great population was supplied with work at good wages, and many men were enriched. But according to the latest information no one has offered to re-imburse the geologist his expenses, nor has any paper in the whole region suggested that the geologist had anything to do with bringing about the development.

Geological work in this as in other lands was originally vacation work, but eventually the investigations became too extensive and the problems too broad for the usually limited means of the students. Meanwhile, it became manifest, as in the case just referred to, that important economic results were almost certain to follow publication of matters discovered by geologists, so that men interested in economics were ready to assist in securing State aid to advance geological work. As one of our Fellows remarked the other day, economic geology has been the breastwork behind which scientific geology has been developed by State aid.

Ducatel's reconnaissance proved the importance of Maryland's coal field and the survey was ordered; the Pennsylvania Geological Society discussed coal fields until the Legislature gave the State a survey; the geologists of New York promised to settle, finally, the question of the occurrence of coal within the State; and so in many other States.

The United States Geological Survey had a somewhat different origin, for the economic side did not attain importance until a late period. Soon after the annexation of California the necessity for railroad communication with the Pacific became appar-

ent, and Congress ordered exploration of several lines across the Rocky Mountain region. At that time, the early 'fifties, the perplexities of American geologists had reached a maximum. Most of the old State surveys had come to a close, rich in economic results and still richer in problems to be solved only by elaborate investigation, too extended and too costly for those days. The observations made by Wislezenus and army officers in New Mexico, by Fremont and Stansbury farther north in the Rocky Mountain and Plateau regions, as well as by Culbertson and Norwood in the Dakota country, had stirred the curiosity and awakened the interest of geologists everywhere. Strong pressure was brought to bear on the Secretary of War for the appointment of geologists to positions on the several parties. The efforts were successful and the appointments were made, though in most instances the geologists were physicians and appointed as acting surgeons in the army. This was an important advance in scientific work, for, almost without exception, exploring parties under the War Department from that time were accompanied by naturalists. The Civil War brought the Western work to a close, but when peace returned it was taken up again and geology was recognized as a necessary part of it, until at last the fragmentary works were placed in one organization and the Survey established as it now exists.

In all of the later geological surveys the element of economics entered more largely into consideration and was emphasized in the legislative enactments. Men recognized that geological investigation had led to the discovery of laws, most important from the economic standpoint, and they were anxious to have the knowledge utilized in a broad way.

Looking over the history of the old surveys one sees clearly that their origin was due solely to a desire for solution of prob-

lems in pure science. The credit for the economic outcome of the scientific work is due to the geologist alone, to whom the appropriations were given, practically as a gift. The Legislators soothed their consciences by lofty speeches respecting the duty of the Commonwealth to foster the study of Nature, but they generally had an aside to be utilized as a justification before their constituents—"especially when there is a very reasonable chance that something of value will be discovered to the advantage of our Commonwealth."

The New York survey had for its possible outcome the determination of the coal area. The work was completed with great exactness, for it proved that the State contains no coal area whatever. Though only negative in results for the State, this survey has proved of incalculable service to the country at large, for it first elaborated the lower and middle Paleozoic sections; the scientific work, continued along the biological line, defined accurately the vertical limits of fossils and provided means for removal of difficulties where the succession is incomplete and for tentative correlation in widely separated localities, an apparatus whose usefulness cannot be overestimated from an economic standpoint.

If the man who makes two blades of grass grow where only one grew before be a public benefactor, what shall be said of the geologist who turns a desert into a garden? This was done by the first survey of New Jersey, which differentiated and mapped the marls of that State, giving a complete discussion of their nature and value. Great areas of the 'whites and barrens' have been converted not into mere farm lands, but into richly productive garden spots. In later years the second survey, now almost forty years old, did, as it is still doing, admirable work along the same lines; the study of structural geology gave a clue to the causes of restrained drainage, and in not a few in-

stances showed that relief from malaria could be obtained with unsuspected ease, and that many miles of noxious swamp could be converted into lands well fitted for residence.

The first survey of Pennsylvania was purely scientific in inception and execution. Economic questions had little of interest for its head, and in the work their place was very subordinate to those in pure science; yet the outcome was inevitable. The study of the Appalachian folds and the discovery of the steeper northwesterly dip revealed the structure of the anthracite region and made it possible to determine the relations of the anthracite beds; the vast extent of the bituminous area and the importance of the Pittsburg coal bed were ascertained during the search for facts to explain the origin of the coal measures; the ores of the central part of the State were studied with rigorous attention to detail that the problem of their origin might be solved. But these and other scientific studies brought out a mass of facts which were seen at once to possess immense importance, and the reports were published broadcast. New industries were established; old ones, previously uncertain, became certain and developed prodigiously; the coal and iron interests moved at once to the front, so that, within two or three years after the survey ended, 'Tariff' became the burning political question throughout the State. The results of the second survey were even more remarkable in their influence upon the development of the Commonwealth and the increased comfort of the population.

Among the earliest results of the first survey of Michigan was the determination of the value of the salt lands and the announcement of iron ore in the Upper Peninsula. The successors to this survey, but under the United States supervision, made studies of numerous localities and determined the excellence of the ores. Un-

questionably, the importance of the deposit became known to capitalists very largely through the reports of this survey, though at that time economic geology had no charms for its head. Much of the enormous development of the Lake Superior iron region was due to the influence of the later survey between 1869 and 1873.

The first Ohio survey, made sixty years ago, was at greater disadvantage than the Pennsylvania survey, yet in the first year the coal area was defined and during the second the geologists determined the distribution of the several limestones and sandstones which, as building stones, have become so important. The second survey was made effective at once by the tracing and identification of the Hocking Valley coal, which brought into the State a vast amount of new capital and changed the face of a great district. The third survey determined the distribution of oil and gas, the relations of the coal beds and the characteristics of the clay deposits in such fashion as to remake the manufacturing interests of the State.

The Mesabi and Vermilion ranges of Minnesota contain deposits of iron ore which, for the present at least, appear to be even more important than those of northern Michigan. Almost fifty years ago J. G. Norwood, while studying the easterly end of the region, discovered the Mesabi ores; a few years later Whittlesey, after a detailed examination farther west, predicted the discovery of similar ores, a discovery actually made in 1866 by Eames, who was then State Geologist and engaged in studying the Vermilion range. Though not utilized at once, these announcements were not forgotten and systematic exploration was begun in 1875, when the need of high-grade ores at low prices made necessary the opening of new areas. Almost at once, the State Geological Survey determined the extent of the ore-bearing region,

differentiated the deposits and removed erroneous impressions respecting the extent and distribution of the ores. The effect of discussion and of the positive fixing of areas has been to increase development and to cheapen ores of the best quality so far that Bessemer steel can be manufactured more cheaply in the United States than elsewhere, in spite of the fact that wages are still higher, not simply numerically, but in purchasing power, than in any other iron-producing country. An examination of the reports which have brought about this result compels one to say that the anxiety for economic results does not appear to have been an impelling motive during the work. There were perplexing geological problems to be worked out, and the solutions could be discovered only by the most painstaking work. This investigation led to the economic results.

The United States Survey retained its original character for a number of years, the studies being devoted almost wholly to pure science. There were those who looked upon the elaborate petrographical work as merely an elaborate waste of public funds; who, like the member of the Ohio Legislature, regarded fossils only as 'clams and salamanders' and considered the diagrams of sections as merely bewildering humbug, while they asserted that attention ought to be given to other matters, which, however, they were not always ready to designate. But the outcome of these studies was the inevitable; petrography has its applications now in the investigation of building stones, and it has proved of service in aiding to determine the source of precious metals at more than one important locality. The determination of fossils has led to the proper definition of the great coal horizons of the Upper Cretaceous; the close study of stratigraphical relations made possible a wide development of artesian well systems in the Dakotas, just as similar work in Eng-

land led to the same practical result; while the study of climatic and structural conditions was brought to bear on the great problem of our arid lands with no mean results.

But these illustrations must suffice, not because they exhaust the material—for every official survey on the continent affords illustrations—but because this is an address, not a history, and already the time allotted has been exceeded.

It is the old story—the same in geology as in other branches. The kind of work for which this Society stands lies more closely to the welfare of the community than is supposed even by men in high position and of far more than average intelligence. This work is responsible in large part for the industrial progress of our continent, which we must regard, in spite of protests from those who lament the dominance of commercialism, as the force which has made possible our great advance in physical comfort as well as the equally great advance in literary culture and æsthetic taste. Coal, iron and oil, chief among our products, have been so much the objects of minute study by closet investigators that improvement in processes of manufacture has not been a growth, but rather a series of leaps.

We give all honor to applied science, yet we cannot forget that it is but a follower of pure science. The worker in pure science discovers; his fellow in applied science utilizes; the former receives little credit outside of a narrow circle; pecuniary reward is not his object and rarely falls to his lot; the latter has a double possibility as an incentive, large pecuniary reward and popular reputation in case of noteworthy success. The two conditions are well represented by Henry, the investigator, and Morse, the inventor and promoter.

Men are ignorant of their debt to closet workers because the facts have never been

presented. As geologists and as citizens of no mean countries we ought to present this matter clearly to men whose fortunes have come through application of principles discovered by obscure workers. Such men are quick to perceive the justice of the claim and usually are ready to pay a reasonable interest on the debt.

The world must advance or retrograde; it cannot stand still. Continued advance in physical comfort and intellectual power can come only through intenser application to investigation along the lines of pure science, which can be made possible only by affording increased opportunities for research in our colleges and by the expansion of research funds held by societies such as this.

JOHN J. STEVENSON.

NEW YORK UNIVERSITY.

FISHES OF THE SOUTH SHORE OF LONG ISLAND.

INVESTIGATIONS carried on by the New York State Museum from July to September and continued by the U. S. Fish Commission until near the close of October, 1898, in the waters of the southern part of Long Island resulted in the collection of eighty-four species of fishes belonging to the region.

The work of collecting began July 21st, at Southampton, from which place excursions were made to Shinnecock, Mecox and Peconic Bays and to the ocean beach. The writer was assisted by Mr. Barton A. Bean, on behalf of the U. S. National Museum, during the first month of the explorations. Great South Bay was the scene of operations from August 12th until October 19th.

Fine-meshed seines, a gill net of two-inch stretch-mesh and a trawl line with about 200 hooks were the principal means of capturing the fishes, and a few interesting species were obtained from the haul seines and set nets of fishermen on the ocean

beach and the pound nets in Great South Bay.

A noteworthy feature was the absence of many fishes which had been taken during the summer and fall months in previous years. Among them are: *Albula vulpes*, *Etrumeus sadina*, *Clupea harengus*, *Pomolobus æstivalis*, *Stolephorus argyrophanus*, *Fistularia tabacaria*, *Sphyræna borealis*, *Decapterus punctatus*, *Vomer setipinnis*, *Trachinotus falcatus*, *Trachinotus argenteus*, *Lagodon rhomboides*, *Leiostomus xanthurus*, *Acanthocottus æneus*, *Hemirhamphus americanus* and *Platophrys ocellatus*. Two things contributed to this condition, the prevalence of southerly winds, causing rough seas on the ocean beaches, and high water temperature which kept the migratory fishes well to the north of Long Island until late in October. A very serious hindrance to seining in most parts of the bays was the abundance of living and dead sea weeds near the shores, and another great obstacle was found in the sunken stakes scattered by ice and storms from the fences used as sea-weed collectors.

The sand shark (*Carcharias littoralis*) was abundant on the grassy shallows south of Toby's Flat until the middle of September, when it migrated westward. It preyed upon mullet, eels and flatfish, and, on account of its habit of swimming slowly near the surface, was easily captured by spears from a row boat. A young mackerel shark (*Lamna cornubica*), about three feet long, was caught in a gill net set in the ocean off Southampton. Other sharks secured were the dusky shark (*Carcharhinus obscurus*), the smooth dogfish (*Mustelus canis*) and the horned dogfish (*Squalus acanthias*).

The skates represented three species, *Raja erinacea*, *ocellata* and *eglanteria*, all of which were sufficiently common. They were often found feeding in shallow water near the shores, especially in the evening and night. A large male was taken by the hands, on the night of October 17th, in a

small dug-out creek emptying into Clam Pond Cove. It was at the edge of the shore and partly out of water, having followed the channel to the head of the creek and then failed to discover a way out.

A large menhaden (*Brevoortia tyrannus*) was captured by an osprey in Great South Bay and carried through the air fully two miles. The osprey was struck by a charge of shot and dropped its prey, which was then found to be alive. The young of the menhaden were migrating westward in large schools, swimming near the surface of the bay, on October 1st.

The lizard fish (*Synodus fœtens*), which was obtained almost everywhere in Great South Bay in 1890, was almost entirely absent, only a single example having been secured.

The half-beak (*Hyporhamphus roberti*) was found in small numbers and was occasionally seen swimming in the water. Its movements are closely similar to those of the silver gar (*Tylosurus marinus*). This is one of the species captured at night by the use of a large reflector lantern. The light apparently dazes the fish so that it can easily be taken out of the water with a dip-net.

The small silverside (*Menidia beryllina*) occurs abundantly in fresh and brackish waters throughout the region explored and was once seined in salt water near Fire Island. On September 24th a young individual from Swan River measured one and one-sixteenth inches in length. The rough silverside (*Kirtlandia laciniata*) was added to the New York fauna by the capture of an adult example in Mecox Bay, August 1st. This has the following characters: D. V, I, 7; A, I, 20; P. 14; V, I, 5; scales 7—47. It was associated with the common silverside (*Menidia notata*).

The red mullet (*Mullus auratus*) was obtained, October 17th, from a fish pound near Clam Pond Cove. Although the species

occurs occasionally as far north as Cape Cod, it seems to be recorded now for the first time from Long Island. It was seined by the writer at Sandy Hook, October 8, 1897, and was reported by fishermen to have been abundant there in September and October of that year.

The saurel (*Trachurus trachurus*) was secured in a gill net, October 16th, in Clam Pond Cove, along with young bluefish and menhaden. Young horse-crevallé (*Caranx hippos*) were obtained at several localities in Great South Bay, and the common crevallé (*Caranx crysos*) was brought from a pound near Clam Pond Cove late in October. The thread-fish (*Alectis ciliaris*) is represented by two individuals from a pound near Islip. The look-down (*Selene vomer*) was seined at Duncan's Creek, August 29th. The common compano (*Trachinotus carolinus*) made its appearance in October in the vicinity of Fire Island Inlet. Only the young were obtained.

The black rudder fish (*Palinurichthys perciformis*), usually occurring off shore under floating logs and boxes, made its way into Great South Bay, and one example was caught in Clam Pond Cove, October 11th, by Captain George Yarrington. *Eucinostomus gula*, formerly so abundant in northern waters in mid-summer, is represented in the collection by a single, very small individual, seined in Clam Pond Cove, August 22d.

The yellow tail or silver perch (*Bairdiella chrysura*), which was plentiful in all parts of Great South Bay in 1890, proved to be scarce everywhere except at Nichols' Point, where the young were collected in moderate numbers, September 1st.

A single *Chatodon* (*C. ocellatus*) was obtained from a pound near Clam Pond Cove, October 17th. This is conspicuously beautiful on account of the orange color of its fins contrasting sharply with the dark bands on the head and body. The species was taken

also in Gravesend Bay in October, by Mr. W. I. De Nyse, who informs me that the roundish black spot in the soft dorsal remains fixed under all conditions, while the band extending from it to the anal fin sometimes disappears. The whole body of the fish at times appears to have an orange tinge, but at other times it is gray.

The rabbit-fish (*Lagocephalus lævigatus*) was not seen until October 14th, when a large individual was received from a pound near Clam Pond Cove. This was the only one obtained during the season.

The small-mouthed flounder (*Citharichthys microstomus*) was found in and near Fire Island Inlet on September 30th and October 11th. Ten individuals were taken, of which the largest is about four inches long. In 1890 this species was more abundant and occurred as far west as the Blue Point Life-Saving Station. In 1898 all but one of the recorded specimens were collected in a single haul of the seine.

The following record will serve as an illustration of the sudden changes occurring during the fall migrations: On October 11th, with southerly winds shifting to southwesterly and strong, two hauls were made with the gill net and three with the twenty-fathom seine; the fishes obtained were *Mugil cephalus*, *Mugil curema*, *Alutera schæpfii*, *Prionotus carolinus*, *Prionotus strigatus*, *Menidia notata*, *Fundulus majalis*, *Fundulus heteroclitus*, *Tautoga onitis* young, *Tylosurus marinus*, *Spheroides maculatus*, *Siphostoma fuscum*, *Hippocampus hudsonius*, *Citharichthys microstomus*, *Pseudopleuronectes americanus*, *Bothus maculatus*, *Stenotomus chrysops* young, *Synodus fætens*, *Menticirrhus saxatilis*, *Centropomus striatus* young. To these were added, on the same day, at Clam Pond Cove, several miles farther east, *Palinurichthys perciformis*, *Pomatomus saltatrix*, *Opsanus tau*, *Brevoortia tyrannus* young, and *Bairdiella chrysura*. On October 17th we worked over the same ground, the wind blowing from the

northeast, but gradually moderating. The gill net was hauled, but caught nothing. An orange filefish (*Alutera schæpfii*) was speared. We then looked around east and west along the shore and saw no fish except *Fundulus majalis* and *Menidia notata*. It should be noted, however, that on the same date a pound near Clam Pond Cove furnished us with *Chatodon ocellatus*, *Mullus auratus*, *Elops saurus*, *Caranx crysos*, *Raia ocellata*, *Raia erinacea*, *Alutera schæpfii*, *Mustelus canis* and *Stenotomus chrysops*, while the saurel (*Trachurus trachurus*) was present in Clam Pond Cove on the preceding day.

A large reflector lantern used for 'fire-lighting' eels at night was found useful for the capture of other fishes and for studying their attitudes and movements in the water. On the night of September 16th the lantern was held over the side of our sloop in Clam Pond Cove, and it attracted to us silver gar (*Tylosurus marinus*), killifish (*Fundulus majalis* and *F. heteroclitus*), silverside (*Menidia notata*), half beak (*Hyporhamphus roberti*), annelids (*Nereis* sp.), crabs, shrimp, beetles and moths. By means of a dip net it was easy to take any of the species. On the night of October 13th we were on the south shore of Great South Bay near Horsefoot Creek, spearing eels with the help of the lantern.

We took about twenty pounds of large eels, and nearly all of them were in very shallow water, close to the shore, hiding in the grass or on the sand bottom. One large eel, at the mouth of Horsefoot Creek, was standing on its head, boring for worms when it was speared. The silver gars and silversides played around the light, following it persistently in a semi-dazed fashion. Killifish, toadfish and many crabs were seen resting on the bottom, the toadfish sometimes lying on its side, with its tail curled toward its head. Young bluefish were seen darting out of the way occasionally. Sev-

eral quawks were fascinated by the lantern, and we pushed up close to them before they started off with owl-like motion and discordant cries.

The writer is now able, from personal studies, to report 163 species of fishes in waters extending from Gravesend Bay eastward to Mecox Bay, and refers to his articles published in the Nineteenth Annual Report of the New York Fish Commission (1890) and the Bulletin for 1897 of the American Museum of Natural History, New York City.

The marine fishes now certainly known in the New York fauna represent 200 species. The fresh waters contain 116 species, and there are, besides, 13 anadromous forms. The list might be further increased by the addition of the following fishes concerning whose pertinence to the fauna there is more or less doubt: *Lucius vermiculatus*, *Seriola lalandi*, *Coryphæna equisetis*, *Boleosoma nigrum*, *Polyprion americanus*, *Epinephelus niveatus*, *Dules auriga*, *Zenopsis ocellatus*, *Spheroides trichocephalus*, *Aspidophoroides monopterygius*, *Ulvaria subbifurcata*, *Stichæus punctatus*, *Leptoblennius serpentinus*, *Cryptacanthodes maculatus*, *Anarhichas lupus*, *Trigla cuculus*, *Brosimius brosme*, *Hippoglossoides platessoides*, *Ogocephalus vespertilio*.*

Thus, a catalogue of the New York fishes, based upon our present knowledge and including the foregoing 19 forms doubtfully assigned to the fauna, will contain 348 species. It should be remembered that no systematic account of the fishes has been published since 1842, and many large regions of the State are almost, or altogether, unknown to the ichthyologist.

TARLETON H. BEAN.

*The bat-fish must be transferred to the list of species known to occur in New York. Dr. Theodore Gill, in the mid-summer of 1854 or 1855, saw a recently-caught example of it at a wharf at the foot of 27th Street, East River, New York. No record of its occurrence was published.

SUPPRESSION OF SMOKE.

THE devising of practicable methods of reduction of the 'smoke nuisance' has become one of the most important problems in applied science for our time, and has been a subject of experiment and of legislation for many years past. Of late, some success has been met with on both sides the Atlantic. In St. Louis, perhaps, as great success has been attained as in any city in the United States, through the public-spirited cooperation of the city government, the Board of Trade and the scientific men and leading engineers of the place; but there remains much to be done and investigations are still in progress, some of which are important. Recent discussions at Philadelphia, under the auspices of the Franklin Institute,* have thrown much light upon the subject and have afforded many valuable facts and data.

We have now the published results of another and formal investigation by a commission, organized at Paris, composed of MM. Huet, Brull, Hirsch, Humblot, Lamouroux, Michel-Levy and DeTavernier, all holding important positions in the municipal administration, or in the great schools of mines and engineering, or as leading members of the Society of Civil Engineers. The commission was in session, at intervals, from June, 1894, to October, 1897. It made a study of reports and documents bearing upon the subject, conducted important experiments, reduced them to order and studied out definite conclusions, and also investigated the origin, state and the progress of the art, completing its report at the last-named date. This document of over 150 pages, large 8vo, with 25 plates, is now in process of distribution.†

Although more or less attention had been

* Journal Franklin Institute, June, 1897.

† "Concours pour la suppression des fumées produites par les foyers de chaudières à vapeur. Rapport de la Commission technique. Prefecture du Depart-

given the subject by the municipal government for years, nothing had been accomplished, and it was, in this instance, proposed to organize a technical commission to conduct competitive tests of various methods and apparatus having for their object the suppression of smoke from boiler-furnaces. The above-named commission was accordingly formed and was assigned a credit of 8,050 francs for expenses. The commission was to select acceptable forms of furnace and report to the city government for their license and use. One hundred and ten competitors appeared, their schemes including the following :

GENERAL PLAN OF PROCEDURE.

(1) Mechanical feed and methodical combustion.	16
(2) Supplementary injection of air, hot or cold..	20
(3) Injection of steam, with or without air.....	5
(4) Stirring the gases.....	7
(5) Gas producers and heating the gases.....	7
(6) Combustion of dust fuel.....	2
(7) Washing the smoke	16
(8) Various other systems	37

110

Of the total, three-fourths were French devices, one-fifth English, 3 American, and the others of various European nationalities. A preliminary study led to the careful test of ten. These were tested to ascertain whether they were capable of burning ordinary fuels without smoke and whether they were suitable for use in steam-making.

They were tested with rapid and with slow combustion, with operatives supplied by the makers and with firemen furnished by the commission, under the direction of first the one and then the other. The intensity of the smoke was observed and noted on a scale of five points. The usual standard methods of determining the efficiency of the apparatus were employed. The corps of observation was detailed from

ment de la Seine, Ville de Paris, République Française—Liberté, Égalité, Fraternité." n. d.

the offices of the city administration, organized and directed by the commission.

The history of legislation, as given, traces the progress of the subject in England from the time of Charles II., who, two hundred years ago, inaugurated repressive measures. In France this form of legislation began with an imperial decree in 1810. Both countries now have well-considered laws for suppression of smoke in cities. The technical history, curiously enough, begins with plans by Denis Papin. The next inventor to follow this illustrious man of science was James Watt, with his inverted draught and later arrangement of 'dead-plate.' The 'automatic stokers,' '*très usités en Amérique*,' are referred to and their incidental but none the less effective, smoke reductions are described. Legislation now exists in all civilized countries, and many more or less effective devices and methods are in use for suppression of smoke.

A commission of distinguished engineers and scientific men was organized by the German government, in 1892, which, after prolonged experimental investigation, concluded that success had not been attained, but that the way to success was clearly indicated. This commission, in computing the heating power of combustibles from analyses, adopted the formula : $8000 C + 29000 (H - O/8) + 2500 S - 600 W$; where W is moisture.

The outcome of the work of the French Commission was the refusal to assign a first prize, the awarding of two second prizes, of two first mentions and of one second mention. The conclusions formulated indicate that the Commission is not satisfied that a real success has been achieved, but nevertheless the researches were not without value. Like the German Commission of 1892-4, it is concluded that "The work of the Commission should be considered only as a contribution to the study of 'fumivorté,' and it is to be hoped that these re-

searches may continue. There remains much to be done and a part of this collection of exhibits has very nearly attained the object proposed."

Among the specific conclusions are these:

Smoke cannot be suppressed without considerable excess of cost.

Special fuels, as anthracite, coke, fuel-gas and mineral oils, may be resorted to, and with success, where cost is not objectionable.

The chimney-top should be visible to the man at the furnace.

Prolonged trials should supplement such investigations as those prosecuted by this Commission, to ascertain the durability of the apparatus and of its efficiency.

Existing legislation, well enforced, is advised, rather than any specific new legislation.

The appendix to the report is an elaborate presentation of the logs, tables and drawings of the apparatus of the trials described in the text. The whole constitutes a very valuable contribution to the literature of the subject, in the department of applied science, and deserves to be permanently preserved in every library of applied science, beside the reports of the Franklin Institute discussion.

R. H. THURSTON.

AMERICAN MATHEMATICAL SOCIETY.

THE fifth annual meeting of the American Mathematical Society was held in Fayerweather Hall of Columbia University, on Wednesday, December 28, 1898. On the two following days the Chicago Section of the Society held its fourth regular meeting in the Ryerson Physical Laboratory of the University of Chicago. At the election held at the annual meeting the following officers and members of the Council were chosen: President, R. S. Woodward; First Vice-President, E. H. Moore; Second Vice-President, T. S. Fiske; Secretary, F. N. Cole; Treasurer, Harold Jacoby; Librarian, Pomeroy Ladue; Committee of Publication, T. S. Fiske, F. N. Cole, Alexander Ziwet;

members of the Council to serve for three years, Maxime Bôcher, James Pierpont, Charlotte Angas Scott.

The Society has now completed its tenth year of continuous existence, having been organized as the New York Mathematical Society in November, 1888, and reorganized under its present title in July, 1894. The *Bulletin* is now in its eighth annual volume; the first number appeared in October, 1891. The present membership of the Society is 315. About ninety papers have been presented at its meetings during the past year. The Chicago Section was organized in April, 1897, and has proved from the beginning a valued addition to the Society's strength.

At the annual meeting the following papers were read:

- (1) PROFESSOR M. I. PUPIN: 'On multiple resonance.'
- (2) DR. A. S. CHERRIN: 'On the development of the perturbative function in terms of the eccentric anomalies.'
- (3) DR. A. S. CHERRIN: 'On some points of the theory of functions.'
- (4) PROFESSOR E. O. LOVETT: 'On the transformation of straight lines into spheres.'
- (5) DR. E. J. WILCZYNSKI: 'A generalization of Appell's factorial functions.'
- (6) PROFESSOR ORMOND STONE: 'On the solution of Delaunay's canonical system of equations.'
- (7) DR. VIRGIL SNYDER: 'Asymptotic lines on ruled surfaces having two rectilinear generators.'
- (8) DR. G. A. MILLER: 'On a memoir on the substitution groups whose degree is less than nine.'
- (9) DR. W. SCHULZ: 'On the partial differential equation

$$\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = k e^u$$

and its connection with Dirichlet's principle.'

The following is a list of the papers read before the Chicago Section:

- (1) DR. L. E. DICKSON: 'The determination of the structure of all linear homogeneous groups in a Galois field which possess a quadratic invariant, with the announcement of two new systems of simple groups.'
- (2) MR. CARL C. ENGBERG: 'The Cartesian oval and the auxiliary parabola.'

- (3) PROFESSOR ARTHUR S. HATHAWAY: 'A new way of presenting the principles of the calculus.'
- (4) PROFESSOR H. MASCHKE: 'Some general theorems concerning linear substitution-groups of finite order.'
- (5) PROFESSOR E. H. MOORE: 'Concerning Klein's groups of $n!(n-1)$ -ary collineations.'
- (6) PROFESSOR E. H. MOORE: 'The decomposition of a modular system connected with the doubly generalized Fermat theorem.'
- (7) PROFESSOR H. B. NEWSON: 'Normal forms of projective transformation (second communication).'
- (8) PROFESSOR H. B. NEWSON: 'A new solution of the Riemann-Helmholtz problem.'
- (9) PROFESSOR H. B. NEWSON: 'What constitutes a continuous group?'
- (10) PROFESSOR JAMES B. SHAW: 'Some quaternion integrals and their related classes of functions.'
- (11) DR. H. F. STECKER: 'Non-Euclidean images of plane cubics on rotation surfaces of constant negative curvature.'
- (12) PROFESSOR HENRY S. WHITE: 'Note on certain relations among fundamental covariants of a ternary cubic.'
- (13) PROFESSOR J. W. A. YOUNG: 'The teaching of mathematics in the higher schools of Prussia.'

F. N. COLE,
Secretary.

COLUMBIA UNIVERSITY.

GENERAL MEETING OF THE AMERICAN CHEMICAL SOCIETY.

THE eighteenth general meeting of the American Chemical Society was held in New York on the 27th and 28th of December, and was in every respect a most successful and notable gathering.

The opening session was held at the rooms of the Chemists' Club, 108 West 55th Street, with an attendance of about one hundred and fifty members and visitors.

Dr. McMurtrie welcomed the visitors and then introduced Mr. Randolph Guggenheimer, President of the Council, who welcomed the Society to the city. Professor Alexander S. Webb, of the College of the City of New York, welcomed the Society to the educational and scientific institutions of the city. President C. E. Munroe re-

sponded in behalf of the Society, after which the following papers were read:

'A New Method for the Separation of Arsenic, Antimony, Selenium and Tellurium from one another and from other Metals,' A. E. Knorr; 'Separation of Impurities in the Electrolytic Refining of Copper,' by P. de P. Ricketts; 'The Preparation of Metallic Tellurium,' Victor Lehner.

The meeting was then adjourned to take a special train to the New Jersey Zinc and Iron Company's works at Newark, N. J., where a luncheon was served, and the process of manufacture of zinc oxide was shown. Parties were also made up to visit the Wetherill Concentrator Works, Murphy Varnish Company, Lister's Agricultural Chemical Works and others.

In the evening a business session was held at the club rooms, at which reports were received from standing committees and the retiring President made his address. M. Raoul Pictet gave an interesting discourse on the 'Retardation of Chemical Activities at Low Temperatures.' His subject was illustrated by a lantern projection showing a piece of metallic sodium held on a steel needle and both immersed in hydrochloric acid which had been cooled to the lowest temperature obtainable by means of solidified carbon dioxide. There was no reaction between acid and sodium or the iron until a considerable rise of temperature had taken place.

The second day's session was held at Havemeyer Hall, Columbia University, at which the following papers were read:

'Measurement of Turbidity in Water,' W. P. Mason; 'The Assay of Nux Vomica,' E. R. Squibb; 'The Potato and Cassava Starch Industries in the United States,' H. W. Wiley; 'Notes on the Estimation of Carbohydrates,' Traphagen and Cobleigh; 'The Action of Iodine on the Fatty Amines,' J. F. Norris; 'On the Constitution of Some Canadian Baryto-Celestites,' C. W. Volney;

'Laboratory Notes,' A. C. Langmuir; 'Flame Colorations by Bromides and Chlorides of Nickel and Cobalt,' A. S. Cushman; 'Classen's Reaction as an Aid to Determination of Constitution of Terpene Ketones,' M. C. Burt; 'Sixth Annual Report of Committee on Atomic Weight,' F. W. Clarke.

A luncheon was provided by the New York Section, which was served in the Industrial Laboratory, after which visits to various manufacturing establishments and a demonstration of the properties of liquid air at the College of the City of New York occupied the rest of the day, and a dinner at the Waldorf-Astoria in the evening closed the official program of a meeting which had been successful beyond the expectations of the most sanguine of those who had worked for it.

The attendance was not less than one hundred and fifty at any of the sessions, and among them a number of ladies, who also graced the dinner with their presence.

DURAND WOODMAN.

Secretary

SCIENTIFIC BOOKS.

The Collected Mathematical Papers of ARTHUR CAYLEY. 4to. 13 Vols., each \$6.25. Supplementary Vol., containing Titles of Papers and Index. New York, Macmillan Co. \$2.50.

This republication by the Cambridge University Press of Cayley's papers, in collected form, is the most fitting monument of his splendid fame.

He must ever rank as one of the greatest mathematicians of all time. Cayley exceedingly appreciated this action of the Syndics of the Press, and seven of the large quarto volumes appeared under his own editorship.

As to what these thirteen volumes contain it seems vain to attempt even a summary. They cover the whole range of pure mathematics, algebra, analysis, mathematical astronomy, dynamics, and in particular groups, quadratic forms, quantics, etc., etc.

Though abreast of Sylvester as an analyst, he

was, what Sylvester was not, also a geometer. Again and again we find the pure geometric methods of Poncelet and Chasles, though, perhaps, not full assimilation of that greater one than they who has now absorbed them—von Staudt.

Cayley not only made additions to every important subject of pure mathematics, but whole new subjects, now of the most importance, owe their existence to him. It is said that he is actually now the author most frequently quoted in the living world of mathematicians. His name is, perhaps, most closely linked with the word *invariant*, due to his great brother-in-arms, Sylvester.

Boole, in 1841, had shown the invariance of all discriminants and given a method of deducing some other such functions. This paper of Boole's suggested to Cayley the more general question, to find 'all the derivatives of any number of functions which have the property of preserving their form unaltered after any linear transformation of the variables.' His first results, relating to what we now call invariants, he published in 1845. A second set of results, relating to what Sylvester called covariants, he published in 1846. Not until four or five years later did Sylvester take up this matter, but then came such a burst of genius that after his series of publications, in 1851-4, the giant theory of Invariants and Covariants was in the world completely equipped.

The check came when Cayley, in his second Memoir on Quantics, came to the erroneous conclusion that the number of the aszygetic invariants of binary quantics beyond the sixth order was infinite, 'thereby,' as Sylvester says, 'arresting for many years the progress of the triumphal car which he had played a principal part in setting in motion.'

The passages supposed to prove this are marked '*incorrect*' in the *Collected Mathematical Papers*. But this error was not corrected until 1869 [Crelle, Vol. 69, pp. 323-354] by Gordan in his Memoir [dated 8th June, 1868]: "Beweis dass jede Covariante und Invariante einer binaeren Form eine ganze Function mit numerischen Coefficienten einer endlichen Anzahl solcher Formen ist."

Cayley at once returned to the question, found

the source of his mistake, the unsuspected and so neglected interdependence of certain syzygies, and devoted his Ninth Memoir on Quantics (7th April, 1870) to the correction of his error and a further development of the theory in the light of Gordan's results.

The whole of this primal theory of invariants may now be regarded as a natural and elegant application of Lie's theory of continuous groups. The differential parameters, which in the ordinary theory of binary forms enable us to calculate new invariants from known ones, appear in a simple way as differential invariants of certain linear groups. The Lie theory may be illustrated by a simple example.

Consider the binary quadratic form

$$f \equiv a_0 x^2 + 2a_1 xy + a_2 y^2.$$

Applying to f the linear transformation

$$(1) \quad x = ax' + \beta y', \quad y = \gamma x' + \delta y',$$

we obtain the quadratic form

$$f' \equiv a'_0 x'^2 + 2a'_1 x'y' + a'_2 y'^2,$$

where the coefficients are readily found to be

$$(2) \quad \begin{aligned} a'_0 &= a^2 a_0 + 2a\gamma a_1 + \gamma^2 a_2, \\ a'_1 &= a\beta a_0 + (a\delta + \beta\gamma) a_1 + \gamma\delta a_2, \\ a'_2 &= \beta^2 a_0 + 2\beta\delta a_1 + \delta^2 a_2. \end{aligned}$$

We may easily verify the following identity:

$$a'_0 a'_2 - a'^2_1 = (a\delta - \beta\gamma)^2 (a_0 a_2 - a^2_1).$$

Hence $a_0 a_2 - a^2_1$ is an invariant of the form f . In the group theory it is an invariant of the group of linear homogeneous transformations (2) on the three parameters a_0, a_1, a_2 .

The only covariant of f is known to be f itself. In the Lie theory it appears as the *invariant* of a linear homogeneous group on five variables, x, y, a_0, a_1, a_2 , the transformations being defined by the equations (2), together with (1) when inverted.

In general, the invariants of a binary form of degree n are defined by a linear homogeneous group on its $n + 1$ coefficients, its covariants by a group on $n + 3$ variables.

As in all problems in continuous groups, the detailed developments are greatly simplified by employing the infinitesimal transformations of the groups concerned.

It is readily proven by the group theory that all invariants and covariants are expressible in terms of a finite number of them.

This result is, however, not equivalent to the algebraic result that all rational integral invariants (including covariants) are expressible rationally and integrally in terms of a finite number of such invariants.

Twenty years ago, in my 'Bibliography of Hyper Space and Non-Euclidean Geometry' (*American Journal of Mathematics*, Vol. I., Nos. 2 and 3, 1878), I cited seven of Cayley's papers written before 1873:

I. Chapters in the Analytical Geometry of (n) Dimensions. *Camb. Math. Jour.*, Vol. IV., 1845, pp. 119-127.

II. Sixth Memoir on Quantics. *Phil. Trans.*, Vol. 149, pp. 61-90 (1859).

III. Note on Lobatchevsky's Imaginary Geometry. *Phil. Mag.* XXIX., pp. 231-233 (1865).

IV. On the rational transformation between two spaces. *Lond. Math. Soc. Proc.* III., pp. 127-180 (1869-71).

V. A Memoir on Abstract Geometry. *Phil. Trans.* CLX., pp. 51-63 (1870).

VI. On the superlines of a quadric surface in five dimensional space. *Quar. Jour.*, Vol. XII., pp. 176-180 (1871-72).

VII. On the Non-Euclidean Geometry. *Clebsch Math. Ann.* V., pp. 630-634 (1872).

Four of these pertain to Hyper-Space, and in that Bibliography I quoted Cayley as to its geometry as follows:

"The science presents itself in two ways—as a legitimate extension of the ordinary two- and three-dimensional geometries, and as a need in these geometries and in analysis generally. In fact, whenever we are concerned with quantities connected together in any manner, and which are or are considered as variable or determinable, then the nature of the relation between the quantities is frequently rendered more intelligible by regarding them (if only two or three in number) as the coordinates of a point in a plane or in space: for more than three quantities there is, from the greater complexity of the case, the greater need of such a representation; but this can only be obtained by means of the notion of a space of the proper dimensionality; and to use such a representation we require the geometry of such space.

An important instance in plane geometry has

actually presented itself in the question of the determination of the number of curves which satisfy given conditions; the conditions imply relations between the coefficients in the equation of the curve; and for the better understanding of these relations it was expedient to consider the coefficients as the coordinates of a point in a space of the proper dimensionality."

For a dozen years after it was written the Sixth Memoir on Quantics would not have been enumerated in a Bibliography of non-Euclidean geometry, for its author did not see that it gave a generalization which was identifiable with that initiated by Bolyai and Lobachévski, though afterwards, in his address to the British Association, in 1883, he attributes the fundamental idea involved to Riemann, whose paper was written in 1854.

Says Cayley: "In regarding the physical space of our experience as possibly non-Euclidean, Riemann's idea seems to be that of modifying the notion of distance, not that of treating it as a locus in four-dimensional space."

What the Sixth Memoir was meant to do was to base a generalized theory of metrical geometry on a generalized definition of distance.

As Cayley himself says: " * * * the theory in effect is that the metrical properties of a figure are not the properties of the figure considered *per se* apart from everything else, but its properties when considered in connection with another figure, viz., the conic termed the absolute."

The fundamental idea that a metrical property could be looked at as a projective property of an extended system had occurred in the French school of geometers. Thus Laguerre (1853) so expresses an angle. Cayley generalized this French idea, expressing all metrical properties as projective relations to a fundamental configuration.

We may illustrate by tracing how Cayley arrives at his projective definition of distance. Two projective primal figures of the same kind of elements and both on the same bearer are called conjunctive. When in two conjunctive primal figures one particular element has the same mate to whichever figure it be regarded as belonging, then every element has this property.

Two conjunctive figures, such that the elements are mutually paired (coupled), form an involution. If two figures forming an involution have self-correlated elements these are called the double elements of the involution.

An involution has at most two double elements, for were three self-correlated all would be self-correlated. If an involution has two double elements these separate harmonically any two coupled elements. An involution is completely determined by two couples.

From all this it follows that two point-pairs A, B and A_1, B_1 define an involution whose double points D, D_1 are determined as that point-pair which is harmonically related to the two given point-pairs.

Let the pair A, B be fixed and called the Absolute. Two new points A_1, B_1 are said (by definition) to be equidistant from a double point D defined as above. D is said to be the 'center' of the pair A_1, B_1 . Inversely, if A_1 and D be given, B_1 is uniquely determined.

Thus, starting from two points P and P_1 , we determine P_2 such that P_1 is the center of P and P_2 , then determine P_3 so that P_2 is the center of P_1 and P_3 , etc.; also in the opposite direction we determine an analogous series of points P_{-1}, P_{-2}, \dots . We have, therefore, a series of points

$$\dots, P_{-2}, P_{-1}, P, P_1, P_2, P_3, \dots$$

at 'equal intervals of distance.' Taking the points P, P_1 to be indefinitely near to each other, the entire line will be divided into a series of equal infinitesimal elements.

In determining an analytic expression for the distance of two points Cayley introduced the inverse cosine of a certain function of the coordinates, but in the Note which he added in the Collected Papers he recognizes the improvement gained by adopting Klein's assumed definition for the distance of any two points P, Q :

$$\text{dist. } (PQ) = c \log \frac{AP \cdot BQ}{AQ \cdot BP},$$

where A, B are the two fixed points giving the Absolute.

This definition preserves the fundamental relation

$$\text{dist. } (PQ) + \text{dist. } (QR) = \text{dist. } (PR).$$

In this note (Col. Math. Papers, Vol. 2, p.

604) Cayley discusses the question whether the new definitions of distance depend upon that of distance in the ordinary sense, since it is obviously unsatisfactory to use one conception of distance in defining a more general conception of distance.

His earlier view was to regard coordinates 'not as distances or ratios of distances, but as an assumed fundamental notion, not requiring or admitting of explanation.' Later he regarded them as 'mere numerical values, attached arbitrarily to the point, in such wise that for any given point the ratio $x : y$ has a determinate numerical value,' and inversely.

But in 1871 Klein had explicitly recognized this difficulty and indicated its solution. He says: "The cross ratios (the sole fixed elements of projective geometry) naturally must not here be defined, as ordinarily happens, as ratios of sects, since this would assume the knowledge of a measurement. In von Staudt's *Beiträgen zur Geometrie der Lage* (§ 27. n. 393), however, the necessary materials are given for defining a cross ratio as a pure number. Then from cross ratios we may pass to homogeneous point- and plane-coordinates, which, indeed, are nothing else than the relative values of certain cross ratios, as von Staudt has likewise shown (*Beitraege*, § 29. n. 411)."

This solution was not satisfactory to Cayley, who did not think the difficulty removed by the observations of von Staudt that the cross ratio (A, B, P, Q) has "independently of any notion of distance the fundamental properties of a numerical magnitude, viz.: any two such ratios have a sum and also a product, such sum and product being each of them a like ratio of four points determinable by purely descriptive constructions."

Consider, for example, the product of the ratios (A, B, P, Q) and (A', B', P', Q') . We can construct a point R such that $(A', B', P', Q') = (A, B, Q, R)$. The product of (A, B, P, Q) and (A, B, Q, R) is said to be (A, B, P, R) . This last definition of a product of two cross ratios, Cayley remarks, is in effect equivalent to the assumption of the relation $\text{dist.}(PQ) + \text{dist.}(QR) = \text{dist.}(PR)$.

The original importance of this memoir to Cayley lay entirely in its exhibiting metric as a

branch of descriptive geometry. That this generalization of distance gave pangeometry was first pointed out by Klein in 1871.

Klein showed that if Cayley's Absolute be real we get Bolyai's system; if it be imaginary we get either spheric or a new system called by Klein single elliptic; if the Absolute be an imaginary point pair we get parabolic geometry; and if, in particular, the point pair be the circular points we get ordinary Euclid.

It is maintained by B. A. W. Russell, in his powerful essay on the Foundations of Geometry (Cambridge, 1897), "that the reduction of metrical to projective properties, even when, as in hyperbolic geometry, the Absolute is real, is only apparent, and has merely a technical validity."

Cayley first gave evidence of acquaintance with non-Euclidean geometry in 1865 in the paper in the *Philosophical Magazine*, above-mentioned.

Though this is six years after the Sixth Memoir, and though another six was to elapse before the two were connected, yet this is, I think, the very first appreciation of Lobachévsky in any mathematical journal.

Baltzer has received deserved honor for in 1866 calling the attention of Hoüel to Lobachévsky's '*Geometrische Untersuchungen*,' and from the spring thus opened actually flowed the flood of ever-broadening non-Euclidean research.

But whether or not Cayley's path to these gold-fields was ever followed by any one else, still he had therein marked out a claim for himself a whole year before the others.

In 1872, after the connection with the Sixth Memoir had been set up, Cayley takes up the matter in his paper, in the *Mathematische Annalen*, 'On the Non-Euclidean Geometry,' which begins as follows: "The theory of the non-Euclidean geometry, as developed in Dr. Klein's paper '*Ueber die Nicht-Euclidische Geometrie*,' may be illustrated by showing how in such a system we actually measure a distance and an angle, and by establishing the trigonometry of such a system."

I confine myself to the 'hyperbolic' case of plane geometry: viz., the Absolute is here a real conic, which for simplicity I take to be a circle; and I attend to the points *within* the circle.

I use the simple letters, a, A, \dots to denote (linear or angular) distances measured in the ordinary manner; and the same letters with a superscript stroke \bar{a}, \bar{A}, \dots to denote the same distances measured according to the theory. The radius of the Absolute is for convenience taken to be $= 1$; the distance of any point from the center can, therefore, be represented as the sine of an angle.

The distance \overline{BC} , or say \bar{a} , of any two points B, C is by definition as follows:

$$\bar{a} = \frac{1}{2} \log \frac{BI \cdot CJ}{BJ \cdot CI}$$

(where I, J are the intersections of the line BC with the circle).

As for the trigonometry "the formulæ are, in fact, similar to those of spherical trigonometry with only $\cosh \bar{a}$, $\sinh \bar{a}$, etc., instead of $\cos a$, $\sin a$, etc."

Cayley returned again to this matter in his celebrated Presidential Address to the British Association (1883), saying there: "It is well known that Euclid's twelfth axiom, even in Playfair's form of it, has been considered as needing demonstration; and that Lobatschévsky constructed a perfectly consistent theory, wherein this axiom was assumed not to hold good, or say a system of non-Euclidean plane geometry. There is a like system of non-Euclidean solid geometry."

"But suppose the physical space of our experience to be thus only approximately Euclidean space, what is the consequence which follows?"

The very next year this ever-interesting subject recurs in the paper (May 27, 1884) 'On the Non-Euclidean Plane Geometry.' "Thus the geometry of the pseudo-sphere, using the expression straight line to denote a geodesic of the surface, is the Lobatschévskian geometry; or, rather, I would say this in regard to the metrical geometry, or trigonometry, of the surface; for in regard to the descriptive geometry the statement requires some qualification * * * this is not identical with the Lobatschévskian geometry, but corresponds to it in a manner such as that in which the geometry of the surface of the circular cylinder corresponds to that of the plane. I would remark that this realization of

the Lobatschévskian geometry sustains the opinion that Euclid's twelfth axiom is undemonstrable."

But here this necessarily brief notice must abruptly stop. Cayley, in addition to his wondrous originality, was assuredly the most learned and erudite of mathematicians. Of him in his science it might be said he knew everything, and he was the very last man who ever will know everything. His was a very gentle, sweet character. Sylvester told me he never saw him angry but once, and that was (both were practicing law!) when a messenger broke in on one of their interviews with a mass of legal documents—new business for Cayley. In an access of disgust, Cayley dashed the documents upon the floor.

GEORGE BRUCE HALSTED.

AUSTIN, TEXAS.

Commercial Organic Analysis. A treatise on the properties, proximate analytical examination, and modes of assaying the various organic chemicals and products employed in the arts, manufactures, medicine, with concise methods for the detection and determination of their impurities, adulterations and products of decomposition. By ALFRED H. ALLEN, F. I. C., F. C. S. Third Edition. Illustrated. With revisions and addenda by the author and HENRY LEFFMANN, M.A., M.D. Philadelphia, P. Blakiston's Son & Co. 1898. Volume I., Introductions, alcohols, neutral alcoholic derivatives, sugars, starch and its isomers, vegetable acids, etc.; pp. xii+557; Price, \$4.50. Volume IV., The proteids and albuminous principles; Second Edition; pp. xi+584; Price, \$4.50.

The immediate reason for the present publication of the first volume of the third edition of this well-known work has been the appearance of an unauthorized reprint of the second edition. As the second edition was printed in 1885 it is out of date on some points, and many desirable additions and corrections have been made, partly by Mr. Allen, partly by Dr. Leffmann. The plan of the book not only includes careful directions for the analysis of commercial organic substances, and in many cases a discussion of various methods which have been proposed,

but it also gives very many illustrations of actual cases of adulteration, and of difficult problems in analysis which have come under the observation of the author and of others. These features of the work make it almost indispensable for any chemist who has occasion to make analyses in this field. Any one interested in organic chemistry, indeed, will find very many things in the work which are valuable and useful.

In a work of such extent, and especially in one which has grown to its present form during many years under the hands of a busy analyst, it would be impossible that there should not be some things which do not correspond to the best present knowledge. Thus, the same principle which led the author to give Victor Meyer's air-displacement method for the determination of molecular weights should have been the occasion for giving the freezing-point and boiling-point methods, which would be much more generally useful for analytical purposes. On p. 210 arsenic (from the red phosphorus used in its preparation) should have been given as an impurity to be looked for in ethyl bromide. On p. 247 arabinose is incorrectly given as a hexose. On p. 342 'alumina cream' is given as a reagent with a reference to p. 357, but directions for its preparation cannot be found on that page or by means of the index. Some other criticisms of a similar sort might be made, but it would be a thankless task for a reviewer to select, among thousands of statements which are correct and valuable, a few which might be improved.

The fourth volume is the last of the second edition. It discusses the analysis of proteids and albuminous principles. The first portion of the book gives the classification and general analytical reactions of the proteids. Then follow directions for the analytical examination of the proteids of eggs, blood plasma, urine, plants, milk, meat, of digestion (pepsin, pepsines, etc.) and of blood. Under the head of proteoids or albuminoids, such substances as gelatine, glue, silk, hair and wool are considered. The following statement from the preface is especially significant: "I may here repeat that I am fully conscious that much of the matter of Volume IV. is scarcely such as might be

expected to be contained in a work purporting to treat of Commercial Analysis, but I have thought it better to include all facts possessing for me an analytical or practical interest, believing that what I find useful myself will also be of value or interest to others." It is just because Mr. Allen has made these books inclusive rather than exclusive that they prove so useful to the experienced chemist.

W. A. NOYES.

Sewerage: The Designing, Construction and Maintenance of Sewerage Systems. By A. PRESCOTT FOLWELL. New York, John Wiley & Sons. 1898. 8vo. Pp. x+372. Price, \$3.00.

The whole subject of sewerage is naturally divided into three parts: first, the plumbing and drainage of houses; second, the street conduits and their appurtenances; third, the disposal and purification of the sewage. This volume deals with the second part of the subject almost exclusively, only seven pages being devoted to the first and sixteen pages to the third. The facts and discussions are hence mainly from the point of view of the constructing engineer rather than from the sanitary side, and the object is to give directions for building an efficient plant for the removal of sewage from a town and maintaining it in proper repair and cleanliness. This object is accomplished in a very satisfactory manner.

The use of cesspools as a receptacle for the refuse of houses is severely condemned; the author has found the soil of a city street colored black by the liquid from a cesspool 75 feet distant, which must have passed under or around the cellar of a house. The pail systems of removal, used somewhat in France and England, as also the earth-closet system, are regarded as vastly preferable to the cesspool and privy methods which are so generally used in villages, and it is recommended that towns without a water supply should introduce them as a temporary measure. Towns having a good supply of water should introduce a water-carriage system in preference to all other methods on account of its great sanitary advantages.

The two water-carriage systems in common use, called the combined system and the separate system, are described and compared, and

the methods for designing and constructing sewers for each are presented in full detail. The combined system carries both the house sewage and the storm water, while the separate system carries only the former, with a small additional amount of water for flushing. The first system may be the more advantageous when the conditions require an underground system of conduits to dispose of the flood water, and the second may be better when the storm water can be easily carried away through the street gutters. In general, the separate system has been found lower in cost than the combined one for small towns, and hence its extensive use during recent years.

The author's treatment of methods of flushing and cleaning sewers is full and thorough. With respect to ventilation he concludes that chimneys, fans and other devices have been unsuccessful and that no method better than allowing free egress and ingress of air through manholes, street basins and house-roof pipes, has yet been found. Analyses of sewer air have failed to show greater impurity than that in the air of a crowded city street, whether carbon dioxide or number of bacteria be taken as the basis of comparison, and hence no objection except that due to sentiment can be made to this method of ventilation. The methods of cleaning street basins and sewers and of removing obstructions are explained at length; for the small pipe sewers wooden balls called 'pills' are run through with the current, each successive one being greater in size than the preceding; for those larger than one foot in diameter a cylindrical carriage traveling on wheels is employed. The annual cost of cleaning such pipe sewers is said to range from \$4 to \$15 per mile.

The book is carefully written, well illustrated, and contains many tables for facilitating computations. It is the only American work which deals in detail with the construction of the sewers of both the combined and separate systems. This is the correct plan of treatment, for there is no inherent reason why one is preferable to the other, and the engineer, in each particular case, must determine from the local conditions the most economic and efficient system.

M. M.

Cuba and Porto Rico, with the other Islands of the West Indies: Their Topography, Climate, Flora, Products, Industries, Cities, People, Political Conditions, etc. By ROBERT T. HILL, of the United States Geological Survey. New York, The Century Company. 1898. 8vo. Pp. xxviii + 429. 2 maps. 79 plates.

Although popular in treatment, this book contains much information of value to specialists in geology and anthropology. Based primarily on personal observation during several extended journeys through the West Indies, it is enriched by large acquaintance with the literature of the West Indies covering the centuries since the discovery of the New World and the planting of the first European colony on the Island of Martinique. In his first chapter ('The Geographic Relations of the West Indies') the author emphasizes his own generalization as to the genetic independence of the three great regions of the western hemisphere, North America, Central America with its Antillean extension, and South America; in the next three chapters ('The West Indian Waters,' 'The Classification of the West Indian Islands,' and 'The Great Antilles') the subject is expanded and illustrated by details; while the thirty-sixth chapter ('Geological Features of the West Indies') is the most convenient summary extant of the geologic history, structure and mineral resources of this half-submerged portion of the mid-American continent. Additional facts concerning the geology of the islands are scattered through many of the chapters, with significant details concerning the flora, fauna and climate. In the eleventh chapter ('The People of Cuba'), the eighteenth chapter ('The People of Porto Rico'), the twenty-second chapter ('Cities and People of Jamaica') the description of the Republic of Haiti, and the thirty-seventh chapter ('Race Problems in the West Indies'), as well as in other portions of the book, the population is described in a notably appreciative way, the mythology and industries receiving especial attention. Throughout, the volume gives evidence of careful observation and mature thought, as well as a strong grasp of the scientific and social problems of the region; it gives promise of becoming not merely the most

useful current hand-book on the West Indies, but a contribution of permanent value to the literature of that part of the western hemisphere. It is admirably printed, artistically bound, amply illustrated, satisfactorily indexed, and well arranged for reference, as well as for consecutive reading.

W J M.

The Birds of Indiana. By AMOS W. BUTLER. 22d Report of the Department of Geology and Natural Resources of Indiana. 1897. 8vo. Pp. 515-1187. 5 plates and numerous cuts in the text.

Commissions for the preparation of State Natural History Reports so often fall into incompetent hands that all ornithologists, and particularly those students of birds residing in the State of Indiana, may congratulate themselves that a person so well qualified as Mr. Butler was selected to write the work under consideration.

The matter relating to the birds known to occur in Indiana is preceded by sections on the 'Indiana Bird Law,' the physiography of the State (from Dryer's 'Studies in Indiana Geography'), 'Peculiarities affecting Bird Distribution,' 'Changes in Bird-Life,' 'Destruction of Birds,' 'Zoological Areas' and 'Bird Migration.' There is also a bibliography giving some 212 titles.

This is followed by keys to the orders, families, genera and species, and biographies of the 321 species recorded from Indiana, including descriptions of their plumages, general and local ranges, nests, eggs, times and manner of occurrences and habits. The report, in fact, is a complete ornithology of Indiana.

Mr. Butler has followed the excellent plan of securing the best available material, for the use of which he makes ample acknowledgment. Thus his keys are taken from Ridgway's and Jordan's 'Manuals,' his illustrations from the publications of the U. S. Biological Survey and Coues's 'Key,' while the number of local observers quoted assures us that the work contains all existing and desired information and that it will long remain the standard authority on Indiana birds. We trust, therefore, that a sufficiently large edition has been printed to

prevent its early classification with other State lists, which become 'out-of-print' before those who could make the best use of them learn of their existence.

F. M. C.

The Butterfly Book. A Popular Guide to a Knowledge of the Butterflies of North America. By W. J. HOLLAND. New York, Doubleday & McClure Co. 1898. Imp. 8vo. Pp. xx + 382. 48 colored plates. 183 figures in the text. Price, \$3.00.

As the secondary title indicates, this work was prepared to meet a popular need. The preface says: "It is essentially popular in its character. Those who seek a more technical treatment must resort to the writings of others." Nevertheless, it will 'have utility also for the scientific student,' since 'the successful development in recent months of the process of reproducing in colors photographic representations of objects has been, to a certain degree, the argument for the publication' of the work. The forty-eight plates have been reproduced by the new process known popularly as 'three-color printing,' and this is its first application so far as we know—certainly on such a scale—to butterflies. It is, however, an unquestionable and surprising success, destined—if the extraordinarily low price at which the book is sold be any guide—to come into very general use. The representation of the colors as well as of the pattern outstrips all that can be done by chromolithography, and has the added value of an accuracy unattainable except at the high cost of the very best workmanship. As the photographic method employed requires the use of a screen, as in so-called 'half-tone' work, there is a certain loss of vividness, but it appears to be even less than is ordinarily the case with half-tones from a photographic print. This may be seen by an examination of the five plates of caterpillars and chrysalids copied from my 'Butterflies of the Eastern United States,' where direct comparison is available. There are, it is true, a few, but very few, unaccountable and generally very slight changes in tint (as in Pl. 2, Fig. 20; Pl. 3, Fig. 18, and Pl. 5, Fig. 3), and occasionally a blurring, or at least a loss of sharpness, due to imperfect registering, but such mishaps would

ordinarily be noticed only by an expert, so that we must welcome this new process as a great boon. How different copies agree we have not tested.

We have spoken thus in detail regarding the plates, not only from our hope regarding this new process, but because of their special value from a scientific point of view; a large number of the figures being, Chancellor Holland states, photographic reproductions from the types of the butterflies described. Strange to say, it is only in a very few instances that the author has specified *which these are*, and so he has lost an easy opportunity of adding greatly to their value.

Not all the North American species are described or figured in the work, the author quailing before the numerous and rather insignificant *Hesperiidæ*, of which but little more than one-half are treated, and omitting many others found in our lists, but either of doubtful specific validity or differing from their allies by distinctions too fine for any but the expert. This is in the interest of the popular audience to which the work appeals. It is, in fact, an iconography of all the forms interesting an amateur, and more. The only really desirable addition would have been to give more figures of the under-surface where this is characteristic, but one should not quarrel with the generosity here displayed; none can possibly complain that he does not get his money's worth, at least.

As to the text of the work, the first fifth of the book is given up to introductory matter on structure, collecting, etc., and the remainder (except a few interspersed essays) to a systematic but very general account of the insects figured, with very many text illustrations, principally of neuration. The different groups are described as well as the species—a desirable feature, but one not altogether common in popular works; and the classification used is more modern than in most of such books. The author's use of genera is not equal, and is 'conservative'—that is, there are many magazine genera here and there, but with a tendency to the discrimination of later times. The descriptions of the species are short—often very short; and attention is paid to the early stages, but almost absolutely none at all to life-histories,

which should be one of the principal aims in a popular treatise.

The work will surely command a large sale and prove a great stimulus to the study of butterflies. Certainly we have never before had such a generous aid to those wishing to cover the whole field. Why should the publishers stamp the cover 'The Butter-Fly Book?' The author surely is not responsible for this, for the proofs have been well read. The publishers have, otherwise, done their part well; the topography is clear and careful, and there is a good index.

SAMUEL H. SCUDDER.

BOOKS RECEIVED.

Michael Faraday, his Life and Works. SYLVANUS P. THOMPSON. New York, The Macmillan Co. 1898. Pp. x + 308.

The Elements of Physics. EDWARD L. NICHOLS and WILLIAM S. FRANKLIN. Vol. I., Mechanics and Heat. New edition, revised with additions. New York, The Macmillan Co. 1898. Pp. xiii + 219. \$1.50.

Principles of Plant Culture. E. S. GOFF. Madison, The Author. 1899. Pp. 287.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *Psychological Review* for January opens with Professor Münsterberg's presidential address before the American Psychological Association, the subject being 'Psychology and History.' This address, together with other articles that Professor Münsterberg has recently published in the *Atlantic Monthly* and elsewhere on the subject-matter of psychology and its relations to other sciences and to philosophy, will shortly be issued in book form by Messrs. Houghton, Mifflin & Co. Professor J. R. Angell and Miss H. B. Thompson contribute from the laboratory of the University of Chicago a study of the relations between certain organic processes and consciousness, elaborately illustrated with tracings of pulse and breathing. Mrs. C. Ladd Franklin publishes her paper on Professor Müller's 'Theory of the Light-sense,' read before the recent meeting of the American Association. There are other articles on 'Theories of Play,' by Mr. H. M. Stanley; on 'Eucken's Struggle for a Spiritual Content of Life,' by Professor Francis Kennedy, and on 'The Effects of Ether.'

THE *Educational Review* for January, which is the first number of the seventeenth volume, opens with an article by Dr. W. T. Harris on the future of the normal school, reviewing 'the five stages' in education. Dr. Harris quotes for edification the anecdotes of Newton and the apple and Cuvier reconstructing an extinct animal from a single bone. Professor Thurston contributes the paper on professional and academic schools read by him at the Association of Colleges and Preparatory Schools of the Middle States and Maryland, and Dr. E. L. Thorndike points out the sentimentality of nature study, which interferes with the teaching of science.

THE Macmillan Company announces the publication, in February, under the editorship of Mr. Frank M. Chapman, of the first number of a popular bi-monthly magazine, addressed to observers rather than to collectors of birds. The contributors will include John Burroughs, Dr. Henry Van Dyke, Bradford Torrey, Olive Thorne Miller, Mabel Osgood Wright, Annie Trumbull Slosson, Florence A. Merriam, J. A. Allen, William Brewster, Henry Nehrling, Ernest Seton Thompson, Otto Widmann and numerous other writers.

A YEARBOOK of Neurology and Psychiatry is announced by S. Karger, Berlin, edited by Drs. Flatau and Jacobsohn, under the direction of Professor Mendel. The work is prepared with the cooperation of a large number of leading German neurologists, and will perform a useful function, owing to the wide dispersion in many journals of publications on the subjects included. It will give not only a bibliography of some thirty-five hundred titles of the literature of 1897, but also short reviews of their contents.

SOCIETIES AND ACADEMIES.

ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA.

October 4. MR. LOUIS WOOLMAN, reporting on a specimen of the earth said to be eaten in the South, received through Mr. Wilfred H. Harned from Davidson county, N. C., stated that the substance is not diatomaceous. It had been found, on examination by Mr. S. H. Hamilton, to be composed of twenty per cent.

silica and eighty per cent. of kaolin, with a trace of alum.

MR. EDW. GOLDSMITH spoke of the igneous origin of the rocks on the Massachusetts coast. He suggested that they are of the same age as the Pennsylvania traps and may, therefore, furnish evidence of the existence of craters.

October 11. MR. PHILIP P. CALVERT, in connection with the meeting of the Entomological Section, presented a statement on recent study of neuroptera, reviewing the work of the last three years, or since 1895, when a synopsis of the natural history of the dragon-flies was given before the International Congress of Zoology by Dr. De Selys Longchamps, whose work on these insects extends over a period of sixty-seven years. He has described at least one-half of the two thousand recognized species. The important papers published since the date given were reviewed and their scope commented on.

MR. CHARLES S. WELLES described a vast swarm of the larvæ of *Daremma Catalpæ* observed during the summer at Media. The development and distribution of the insect were described and illustrated by specimens.

DR. HENRY SKINNER further commented on the life-history of the species.

MR. WITMER STONE spoke of the distribution and relationship of *Neotoma pennsylvanica* and its separation from the fossil *Neotoma magister*, described by Baird from the caves of Pennsylvania.

October 18. DR. EDW. J. NOLAN presented to the Academy five volumes prepared as a memorial of the late Dr. Joseph Leidy. They consist of a collection of biographical notices, portraits, autograph letters, manuscripts, original drawings of botanical and zoological subjects and notes, the latter having been contributed for the most part by Mrs. Leidy. After describing the contents of the volumes, Dr. Nolan commented on the attainments and personal character of the distinguished naturalist out of loving regard for whom they had been prepared.

MR. JOHN A. SHULZE called attention to specimens of *Isthmia nervosa* from Hudson's Strait. The species was formerly supposed to be confined to the western coast. Its geographical distribution was further considered by Mr. Lewis Woolman and Mr. Frank J. Keeley.

Mr. N. H. HARNED and Dr. J. C. MORRIS spoke of the effect of a plentiful supply of water on the growth of trees.

October 25. Dr. DANIEL G. BRINTON made a communication, illustrated by specimens from the Academy's collections, on the ethnography and resources of the Philippine Islands.

PROFESSOR J. WHARTON JAMES, by invitation, spoke of the Enchanted Meza and considered the statements of Professors Libbey and Hodge on the subject. He believed that, while there was evidence of the former presence of man on the Meza, the weight of testimony was entirely opposed to his ever having had permanent places of abode there.

PROFESSOR LIBBEY, who was present, being called on by the President, recounted his experience in exploring the Meza and dwelt on the care with which he had reached his results. He declared that the cairn described by Hodge and Lummis has been built by himself. He agreed with Professor James that the top might have been temporarily occupied, but he was sure it never was a place of residence.

November 1. Mr. STEWARDSON BROWN described the results of a recent botanical exploration of the South Mountain region of Somerset County, Pa., a district curiously distinct in its vegetation. The characteristic plants were enumerated.

Mr. JOSEPH WILLCOX spoke of the use of fresh-water mussels in the manufacture of pearl buttons.

November 8. Mr. H. A. PILSBRY described the physical characters of the Roan Mountain region of North Carolina, and dwelt in detail on the mollusca collected there. Even when the species are widely distributed they are here remarkable as presenting mountain modifications varying from racial characters to those of distinct species. The carinated forms of *Polygyra*, for instance, are extremely characteristic and found nowhere else. The district, in fact, has more peculiar species than any other outside the tropics. He was at a loss to account for this individuality.

Mr. ARTHUR ERWIN BROWN called attention to the specific characters of the Ourang, his observations being based on specimens in the Zoological Garden of Philadelphia and the

museum of the Academy. He believed in the existence of two well-marked species, the *Simia Satyris* of Linnæus and the *Simia Wurmbeii* of Geoffroy St. Hilaire.

November 15. Mr. S. D. HOLMAN communicated the life-history of *Pleuromonas* as observed in covered life-slides.

Mr. PHILIP P. CALVERT and Dr. BENJAMIN SHARP spoke on the subject of cutaneous respiration.

November 22. Dr. A. F. WITMER, under the auspices of the Anthropological Section, made a communication on involution and the diseases of senility, dwelling on the atavistic tendency to certain diseases with special reference to forms of neurasthenia and their pathological conditions.

Dr. HENRY C. CHAPMAN spoke of the modern theory of the neuron, placing himself on record as believing that it rests on no foundation whatever.

November 29. A symposium was held on the natural history of the Philippines illustrated by specimens from the Academy's collections. Mr. PILSBRY spoke of the distribution and characters of the mollusca; Mr. Witmer Stone of the birds and mammals; Mr. Stewardson Brown of the plants; Dr. Henry Skinner of the lepidoptera, and Mr. P. P. Calvert of the dragon-flies.

Mr. Stone placed on record the recent finding of a small rodent, *Oryzomys palustris*, in New Jersey. It had been discovered in 1816 by Bachman in South Carolina, and the specimen belonging to the Academy, described by Harlan, had been regarded as incorrectly labelled, repeated search having failed to find the form in New Jersey until a week ago, when a number were collected in the southern part of the State by Mr. Henry W. Warrington.

December 6. Dr. FLORENCE BASCOM called the attention of the meeting to the determination of rock constituents with special reference to optical methods, the application of polarized light to the work being particularly dwelt on and illustrated.

December 13. Dr. J. C. MORRIS presented, in connection with the meeting of the Biological and Microscopical Section, a history of microscopic study and the development of microscopes and microscopic preparations during the last

fifty years, dwelling particularly on the work accomplished by Leidy, Goddard, Neill, Hyrtl and Gibbons Hunt before the recent improvements in methods and instruments were heard of. The communication was illustrated by a large number of instruments and slides and was fully discussed by Messrs. Goldsmith, Keeley, Calvert and Dixon.

Papers under the following titles have recently been presented for publication:

Some Cuban Species of *Cerion*. By H. A. Pilsbry and E. G. Vanatta.

Notes on the Growth of the Hobble-bush, *Viburnum lantanoides*. By Ida A. Keller.

The Occurrence of Marcasite in the Raritan Formation. By S. H. Hamilton.

Margarita Sharpii, a new Alaskan Gastropod. By H. A. Pilsbry.

The Bone-Cave at Port Kennedy, Pennsylvania, and its partial examination in 1894, 1895 and 1896. By Henry C. Mercer.

Observations on the Classification of Birds. By Dr. R. W. Shufeldt.

A Study of the Type Specimens of Birds in the Collection of the Academy, with a brief history of the Collection. By Witmer Stone.

Mr. Mercer's paper will be published in the *Journal of the Academy*, the others in the *Proceedings*.

E. J. NOLAN,
Secretary.

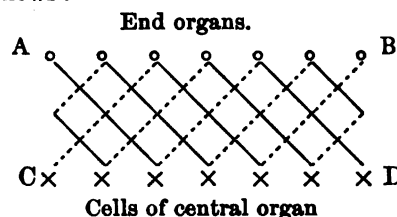
DISCUSSION AND CORRESPONDENCE.

THE SENSATION OF MOTION AND ITS REVERSAL.

TO THE EDITOR OF SCIENCE: The writer has for a number of years noticed, during railway journeys, a very peculiar reversal of sensations of motion received through the eye, of which he has never seen any description or explanation. The following description and explanation may, therefore, interest the readers of SCIENCE. A sensation of reversed motion of stationary points in the field of vision is perceived by the writer after gazing fixedly out of a car window at a moving landscape. This sensation is quite intense when the eyes are first turned away from the window, dies away gradually, and is greatly weakened by attentive vision. For example, when looking out of the rear door of the train the various objects in

the visual field appear to move towards the center of the field, and upon turning the eyes upon an object in the car everything seems to move away from the center of the visual field; if the train comes to a quick stop while the eyes gaze steadily out at a window the motion of the landscape and the inferred motion of the train appears to be momentarily reversed at stopping, etc.

The existence of this sensation of motion of stationary objects seems to indicate that neither the succession of stimuli nor the stimulation of successive nerve elements is the fundamental fact in the sensation of motion, but rather that the sensation of motion, like other specific sensations, depends upon a state of nervous commotion, a state which has, of course, resulted from and is the integral effect of a succession of stimuli. A concrete notion of the character of this state of nervous commotion is as follows:



Let the dots A B represent the end organs of sight—rods and cones—and the crosses C D the nerve cells of the central organ. We may imagine each end organ to be connected, either directly or through ganglion cells, with a number of the cells of the central organ. Let us consider the connections indicated by the diagonal full lines and dotted lines. A succession of stimuli of the end organs from A to B and a succession from B to A would result in radically different states of nervous commotion, especially if the cross connections are not entirely symmetrical or if the connecting nerve fibers are loaded with ganglion cells. Also during a succession of stimuli from A to B the fibers represented by the full lines might be fatigued, while the ones indicated by the dotted lines might be saved by inhibition due to the (outgoing) commotion to which they are subjected in advance of the moving stimulus, so that the effects of this moving stimulus reach

the central organs mainly through the full-line connections. A simultaneous stimulus of all the end organ from A to B would then reach the central organ mainly through the dotted connections just as would a stimulus moving from B to A.

W. S. FRANKLIN.

OCCURRENCE OF THE VIRGINIA OPOSSUM IN SOUTHERN CENTRAL NEW YORK.

DURING the present year several Virginia opossums (*Didelphis virginiana*) have been killed near Owego, Tioga Co., N. Y. Some twelve years ago a farmer residing near here told me he had killed one. Last fall a large female was killed on a mountain side two miles east of this village, and while myself hunting a mile farther east, on December 3d, I met a hunter who had just caught two. He had tracked them a mile or so through the snow, and finally dug them out of a woodchuck's hole. They were both dead when found, probably having starved, as their stomachs were empty. Their skulls are in my possession. Several days later he secured another, an old one, the sex I do not know. It was taken four miles west of where the two young ones were captured. The animal is alive and in his possession. This man is an old-time hunter and trapper, and considered truthful. He told me he had seen their tracks several times before. I have failed to learn of anyone who has liberated a pair of these animals or even had a pair in captivity. The capture of two, early in the fall, has come to me, but I cannot say if it is authentic.

I wish particularly to note that this record comes from Owego, N. Y., not Oswego, two widely separated places.

J. ALDEN LORING.

Owego, N. Y.

NOTES ON INORGANIC CHEMISTRY.

THE December number of the *Journal of the American Chemical Society* contains an extended review of the year's progress in applied chemistry by Dr. Wm. McMurtrie. Development along these lines is going on more rapidly than ever before, and it is encouraging to note that this country is taking its place as an important factor in chemical technology. While

Germany will long hold the first place in those industries in which chemistry plays an important part, America has already become an important factor, especially in the field of electro-chemistry, and it requires little effort of the imagination to see, in the not-far-distant future, the supremacy crossing the water. Dr. McMurtrie's review is well worth careful perusal by the economist as well as the chemist. Only a few points can be noticed in this column. In Germany, at the close of 1896, 96 chemical works, with \$64,000,000 capital, gave a return of nearly \$8,000,000, an average of 12.3% as against 8.9% for 1897. Of these the coal tar industries gave the highest returns, 24%, while the fertilizer industries gave the lowest. An interesting announcement has been made by Dupre that gold can be extracted from ores by an inexpensive solution containing sodium thiosulfate, ferric halids, with an acetate. The solution extracts fifteen to twenty times as much gold as a cyanid solution in the same time, and does not attack sulfids; hence, if the success of the process is confirmed, it may be expected to replace the cyanid and chlorination processes for low-grade and sulfid ores. Great progress has been made in the metallurgy of zinc, and there is every reason to believe that within a few years the old and unsatisfactory process will be entirely displaced, except for very pure ores. The use of the electric furnace is revolutionizing the preparation of phosphorus, and with the increased production in France and Russia, and prospective developments in Germany and at Niagara Falls, the English monopoly is seriously threatened. The advantages of the new processes are both the reduction of price and the increased protection of the health of the operatives. The electrolytic alkali industry is still in an experimental stage, but with the certainty of future success, indeed, it may be said that the great question to-day is the selection and development of the best electrolytic method. Already in the manufacture of potassium chlorate the electrolytic methods have taken the lead, with a consequent marked fall in price. The commercial production of liquid air and of oxygen on a large scale will render possible many new developments along many lines. The production of calcium carbid

and acetylene continues to attract much attention. Ten French factories are now making calcium carbide and four more are being built, and it is said two French villages are lighted wholly by acetylene gas, at a cost of 50 per cent. less than coal gas. On the other hand, Welsbach is making improvements in his burner, and Nernst gives hope of a yet more brilliant and economical source of light, as has already been described in the columns of SCIENCE. In conclusion, Dr. McMurtrie says: "In every direction industrial progress is suggestive, and we may expect advancement in all directions with increasing intensity. Commercial artificial indigo, commercial artificial silk, commercial mercerized cotton in its various forms, the new colors and medicinal substances from carbon compounds, new concentrated nutritive substances, synthetic albumen, the various toxins and extracts of animal matters of therapeutic value, all claim a large share of attention; and so do hundreds of other substances and processes in which the principles of chemistry find application to human needs."

In the Italian *Gazetta* Rebuffat contributes an exhaustive study of hydraulic cements. These he divides into two classes: (1) amorphous, compact cements, which consist of lime, calcium orthosilicate and calcium aluminate, in which, however, the free lime may be wanting; this class contains the hydraulic limes and quick settling cements. (2) Crystalline cements, consisting of a crystalline compound of calcium orthosilicate and lime, with a varying quantity of calcium aluminate; this class contains Portland cements and those rich in silica. After hardening, however, all these cements have the same qualitative composition, consisting of a mixture of calcium hydrate, hydrated calcium silicate of the formula $2(\text{SiO}_2, 2\text{CaO}), \text{H}_2\text{O}$, and hydrated calcium aluminate, with a small amount of inert matter. In cements rich in silica a small amount of a double silicate of calcium and aluminum is present, which accounts for the resistance of these cements to sea water. The hardening of cements is chiefly due to the hydrating of the calcium silicate, and to a lesser degree to the hydrating of the calcium aluminate.

In a recent English patent Weil and Levy claim to electroplate aluminum in baths to which various organic substances are added. Thus for the deposition of silver, hydroquinol is added to an ammoniacal cyanid solution; for copper, ammonium gallate or pyrogallate is used; for nickel, milk sugar, and the same for gold.

J. L. H.

CURRENT NOTES ON METEOROLOGY.

CLIMATE AND HYGIENE OF THE CONGO FREE STATE.

AN important volume on the climate, soil and hygiene of the Congo Free State has been issued as the second part of the Proceedings of the *Congrès National d'Hygiène et de Climatologie Médicale de la Belgique et du Congo*, held in Brussels, August 9-14, 1897. The investigation, of which the results are embodied in this report, was undertaken by a commission of the *Société royale de Médecine publique et de Topographie médicale de Belgique*. On this commission meteorology was represented by M. Lancaster, Director of the Meteorological Service of Belgium, which is equivalent to saying that whatever concerns meteorology and climatology in this report is admirably done. As a whole, this volume gives us the most complete and most scientific account of the meteorology and medical climatology of this interesting district that has yet appeared. The first chapter, of 404 pages, is devoted to the meteorology, and presents a careful summary of what is known concerning the atmospheric conditions and phenomena of the region, including many tables and diagrams. This portion of Africa is one of great interest to meteorologists on account of the seasonal migration of the belt of equatorial rains, and the data concerning the rainfall at Vivi and other stations are, therefore, especially welcome. Chapter II., of twenty pages, is devoted to the geology and soil conditions. Over 400 pages are concerned with the medical climatology and hygiene of the region in general and of the different stations in particular. This last chapter is an extremely valuable one. Of especial interest at the present time is the evidence afforded (p. 464-5) by the result of European colonization in the Congo Free State

that, contrary to the general rule, northern Europeans have succeeded there better than southern Europeans. Italian laborers on the railroad are reported as having suffered more from the climate than many Scandinavians employed on the river. It must be remembered, however, that, of the two occupations, railroad construction and steamboat service, the latter is usually far more healthy, especially in a tropical climate, and a higher disease and death rate are naturally to be expected among persons engaged in the former occupation.

A NEW MOUNTAIN ANEROID BAROMETER.

WHYMPER, in the London *Times* of December 17, 1898, describes a new mountain aneroid which gives results of astonishing accuracy. The ordinary aneroid is well known as being a very inaccurate instrument at high altitudes. In Appendix C ('Comparisons of the Aneroid against the Mercurial Barometer'), in his 'Travels amongst the Great Andes of the Equator,' Whympfer himself says that "with aneroids of the present construction it is unlikely that decent approximations to the truth will be obtained at low pressures, even when employing a large number of instruments." The errors in Whympfer's whole series of observations amounted in the worst cases to as much as two inches, as compared with the mercurial barometer. The new barometer is the invention of Col. H. Watkin, C.B., Chief Inspector of Position-Finding in the (British) War Department. It is so constructed that it can be thrown out of action when not in use, and put in action when required. When out of action no variations in atmospheric pressure, however large, produce any effect on it. This adjustment is effected by having the lower portion of the vacuum box so arranged that it can rise, instead of having it fixed, as is usually the case. A screw arrangement is attached to the lower portion of the vacuum chamber, and under ordinary conditions this screw is released and the chamber put out of strain. When a reading is to be made, the screw is turned as far as it will go, thus bringing the instrument into the normal condition in which it was graduated. Whympfer has made a large number of readings with the new aneroid and finds the error, in

the mean of 65 observations, below ± 0.0 in. He feels confident that, "in the hand of those who will give the requisite attention, extraordinary results may be obtained from Watkin's Mountain Aneroid in observations made for altitude and in determining differences of level." The instrument is made by J. J. Hicks, 8 Hatton Garden, London.

R. DEC. WARD.

HARVARD UNIVERSITY.

ZOOLOGICAL NOTES.

THE NEW YORK ZOOLOGICAL PARK.

BULLETIN 3 of the New York Zoological Society bears testimony to the rapid progress that has been made since July 1, 1898, as may be seen by the following statement of work completed up to December 1, 1898. The Elk House has been practically finished. The Bird House is ready to receive its roof. The foundation walls of the Reptile House have been completed, and the steel floor-beams put in place. All excavating for the first series of Bear Dens has been completed, also all plumbing for drainage and water-supply. The brick walls of the bathing-pools have been built, and stone walls to carry the iron work. The excavation of ponds for the Ducks' Aviary and the construction of three islands have been completed. On the south island twelve enclosures have been laid out, with suitable shelter-houses, and about one hundred native shrubs have been planted. A stone wall, going down to bed rock, has been constructed around the Prairie Dogs' Knoll (eighty feet in diameter), and capped with cut stone. Excavations have been made for the walls and stone work of eight Wolf and Fox Dens, and the walls have been laid ready for the cage work. One sleeping den for wolves has been constructed. About five hundred cubic yards of sandy earth has been hauled to the Pheasant's Aviary, to make dry ground for the runways. This was removed by necessity from the Bear Dens, at no cost to the Aviary. The excavation for the Beaver Pond has been completed, and all the grading necessary thereto. The excavation necessary for the Buffalo House has been made. A trench nine hundred and sixty-three feet in length, has been dug for the stone walls to

support the iron fence for the Beaver Pond. The Society is in urgent need of an antelope house and a monkey house, and it is hoped that these will come as gifts from individuals, as the provision hitherto made is for the accommodation of American quadrupeds and birds, and this will exhaust the \$106,000 at the disposal of the Society.

The most elaborate of the structures commenced is, by all odds, the Reptile House; this will have a length of 146 feet and a width of 100. It is being constructed of buff mottled brick, combined with granite and terra-cotta. It will be roofed with slate, heated by hot water, and its cost, with cages, will be about \$40,000. It is beautifully situated on the edge of a forest of great oaks, very near the geographical center of the park. Close to the southeastern corner of the building is a natural pool in a wide outcrop of granite rock, which will speedily be converted into a summer home for saurians.

It is hoped that the Reptile House can be completed by April, 1899, in time to receive its cages and collections for the opening of the park in May.

The Director has found it necessary to give a chapter 'concerning the purchase of wild animals,' which deserves to be widely read, since with the proper changes it may be made to apply to collectors in various branches of history. The gist of it is contained in the following paragraphs:

"Not unfrequently it happens that a hunter who captures an animal that to him is strange imagines that it is worth double its real value, and feels indignant when a zoological garden offers him what is really a fair price. In about nineteen cases out of every twenty the man who captures a wild animal thinks it is worth far more than it really is. For example, if we were to offer a farmer's boy \$2.50 for a wild goose that he had caught and cooped, the chances are he would be highly indignant; but at this moment we know of thirty-two wild geese for sale, property crated, at that price.

If we were asked to name the greatest small annoyance that comes in the daily mail of a zoological park we would reply: The letters which say, 'What will you give me for it?' Very often not the slightest clue is given to the

size, age, sex or condition of the captive animal. All these are left to be divined by the man who is asked to submit an offer."

F. A. L.

THE STATISTICAL METHOD IN ZOOLOGY.

THE statistical method of biographical investigation has recently been used by Walter Garstang, the naturalist in charge of the fishery investigation of the Plymouth Laboratory, with great success. He claims that it is possible to identify the different schools of fish which approach the shore, even when these schools are made up of individuals which appear to be quite alike. He shows that the mackerel of the American coast are really different from the animals of the same name found along the European coast, and he further shows that the mackerel which frequent the shores of the British Isles may be sub-divided into two principal races, an Irish race and a race frequenting the English Channel and the North Sea. It thus seems that a species heretofore supposed to be widely distributed and given to migrating over long distances of the ocean is really cut up into a number of races, which probably do not intermingle and which may have very limited ranges. If it can be proved—and it now appears to be proved—that the local representatives of each species of animals are branded with indices of consanguinity, which indices may be detected through the plotting of curves of frequency, a new and most fascinating line of investigation is opened to the zoologist, the comparative anatomist and the student of geographical distribution.

H. C. B.

BOTANICAL NOTES.

A BOTANICAL ALMANAC.

A HANDY little book, bearing the title of 'Deutscher Botaniker-Kalender für 1899,' has been prepared by Paul Sydow, of Berlin. It is modeled after the well-known 'Chemiker Kalender' of Dr. Biedermann, which for twenty years has been well-nigh indispensable to the chemists and physicists. This botanical almanac includes a diary (in which notable events, as the births and deaths of great botanists, are recorded), a money table, tables of weights and

measures, the 'Berlin Rules,' catalogue of exsiccata, catalogues of botanic gardens, botanical museums, botanical collections and places where deposited. The publishers (Borntraeger, Berlin) have done their part well, both in printing and binding. The light-colored linen cover and its conventionalized water-lily ornamentation are in most excellent taste.

CHECK LIST OF FOREST TREES.

A VERY convenient, revised and condensed edition of Sudworth's 'Arborescent Flora of the United States' has recently been issued by the Division of Forestry, under the title 'Check List of the Forest Trees of the United States.' It makes use of the modern nomenclature, gives lists of common names, and includes notes as to the range of each species. The following corrections should be made in a later edition:

Pinus ponderosa scopulorum Engelm., add in Nebraska eastward along the Niobrara River to the 99th meridian, and to the 103d meridian on the North Platte and Lodge Pole Rivers.

Hicoria ovata (Mill.) Britt., change to southeastern instead of northeastern Nebraska.

Hicoria laciniosa (Michx. f.) Sarg., add southeastern Nebraska.

Hicoria alba (Linn.) Britt., add southeastern Nebraska.

Populus tremuloides Michx., change from southern to western Nebraska.

Quercus velutina Lam., add southeastern Nebraska.

Asimina triloba (Linn.) Dunal., add southeastern Nebraska.

Pyrus coronaria Linn. This species is recorded in local catalogues as occurring in eastern Nebraska, but it is *P. ioensis* (Wood) Bailey, if this is to be regarded as a distinct species.

Prunus demissa (Nutt.) Walp., add from central Nebraska westward.

Cercis canadensis Linn., add southeastern Nebraska.

Rhus copallina Linn., add southeastern Nebraska.

Acer saccharum Marsh., strike out eastern Nebraska, as this species does not occur in this region in the wild state, although freely planted.

Acer rubrum Linn., strike out eastern Nebraska, as this species does not occur in this region in the wild state, nor is it often planted.

Aesculus glabra Willd., add southeastern Nebraska.

This check list will render a good service not only to botany, but still more to forestry and horticulture, in giving currency to the revised nomenclature of our forest trees.

CRETACEOUS AND TERTIARY PLANTS.

F. H. KNOWLTON, phytopaleontologist of the United States Geological Survey, publishes, in Bulletin 152 of the Department of the Interior, a most valuable catalogue of the Cretaceous and Tertiary plants of North America. In Lesquereux's catalogue of twenty years ago but seven hundred and six species were included, of which one hundred and fifty seven are from the Cretaceous, and five hundred and forty-nine from the Tertiary. In the list before us about twenty-five hundred species are included. The list is strictly alphabetical and is not divided so as to enable one to easily estimate the number from each period. The date and place of publication of each genus and species are given with much care. The modern nomenclature is used, even to trinomials and the double citation of authors. Much attention is given to synonymy, and to the citation of the more important references, especially to such as include descriptions and figures.

LEWIS AND CLARK'S PLANTS.

THOMAS MEEHAN was fortunate enough to discover, some time ago, in the custody of the American Philosophical Society, some packages of dried plants which, on examination, turn out to be the long-lost collection made by Lewis and Clark, in 1803 to 1806, during their expedition across the Western country from St. Louis to the mouth of the Columbia River. They were examined by Dr. B. L. Robinson and J. M. Greenman, of the Herbarium of Harvard University, and compared with Pursh's treatment of this collection, in his *Flora Americae Septentrionalis* in 1814, and the results have been published in the Proceedings of the Academy of Sciences of Philadelphia (January, 1898). Mr. Meehan notes that 'this collection contains all but sixteen of Lewis's plants as described by Pursh in his Flora,' and of the missing numbers seven are represented in the herbarium of the Academy by authentic specimens from Lambert's herbarium. Mr. Meehan says further that 'only a few of these seven missing ones are of material importance,' and that 'for all practical purposes all the plants of Lewis and Clark's expedition are now deposited in the Academy.'

CHARLES E. BESSEY.

THE UNIVERSITY OF NEBRASKA.

CURRENT NOTES ON ANTHROPOLOGY.

ARROW FEATHERING IN SOUTH AMERICA.

AN excellent study of this subject by Herman Meyer has been translated and published in the Smithsonian Report for 1896 (just issued). Different methods of feathering, seven in number, are shown to have prevailed among the native tribes, each occupying its own area and generally embracing tribes of contrasted affinities in other respects. A map is added indicating these areas. The explanation of this is that many tribes first learned the use of the bow from their neighbors, but that there were as many centers of its invention as there were modes of feathering. At least, this is the simplest explanation, and it is one supported by language, as we find, in the Catoquina, for instance, the words for bow and arrow are both Tupi, and their people have the Tupi plan of feathering. The paper is valuable for other suggestions on native culture.

A STUDY OF THE LIPS.

WE are all familiar with the teaching of the physiognomists that thick lips indicate a sensual disposition, and delicate, finely formed lips coincide with a certain spirituality, firmness and elevation of character. Dr. A. Bloch, in a thorough study of the lips from an anthropological point of view, believes that all such indications are imaginary. The form, size and color of these organs belong to race distinctions quite as much as the shape and dimensions of the nose. In fact, they are often in correlation. The pigmentation is notably different in the various sub-species of man, varying from a delicate rose to a dark brown. In hybridity, like many other traits, the lips of one or the other parent may reappear in full character in the child. Really thick lips never occur, except as an anomaly, in the white race. (*Bull. Soc. Anthropologie de Paris*, 1898; Fasc. 3.)

PHYSIOLOGY OF CRIMINALS.

AN eminent criminal lawyer once told me that the criminals, as a rule, were better looking men than the 'gentlemen of the jury.' The assertion seemed jocose, but now comes the proof of it. Dr. J. Marty, a French criminologist, reports his examination of 4,000 delin-

quents in the French army. His results are curious. In height, in weight, in breast measure, in muscular power and in general condition these rascals averaged decidedly better than the well-behaved soldiers of the army!

But Dr. Marty is ready with an ingenious suggestion. Not that criminals are 'by nature' a finer lot physically than non-criminals, but the condition of criminal families is so much more wretched than respectable ones that only the uncommonly strong survive! Ingenious, but not quite satisfying. (*Centralblatt für Anthropologie*, Heft. 4.)

D. G. BRINTON.

UNIVERSITY OF PENNSYLVANIA.

SCIENTIFIC NOTES AND NEWS.

ENDOWMENT OF THE JENNER INSTITUTE.

WE announced in a recent issue a gift by Lord Iveagh of £250,000 for the endowment of the Jenner Institute of Preventive Medicine. Further details of this important gift are given by Lord Lister, Chairman of the Council, and Sir Henry E. Roscoe, Treasurer, in the following letter to the press:

We ask permission to announce in your columns a splendid offer in aid of scientific research which has been placed in our hands.

British and Irish men of science have long deplored the fact that the opportunities in this country for research directed to the prevention of disease are not equal to those possessed by foreign nations.

Lord Iveagh wishes to help in removing this reproach to our country, and, on the conditions named below, has offered the sum of £250,000 (two hundred and fifty thousand pounds) for the purposes of the highest research in bacteriology and other forms of biology as bearing upon the causes, nature, prevention and treatment of disease.

He has proposed to the Council of the Jenner Institute (lately the British Institute) of Preventive Medicine—a body which includes leading men in medicine and allied sciences in the British Isles—that the donation shall be handed over to the Institute on condition that in future the control and management of the affairs of the Institute shall be placed in the hands of a new board of seven trustees—three of the seven to be chosen by the Council of the Institute, three by the donor, and one by the Council of the Royal Society.

The offer has been cordially accepted at a meeting of the Council.

The donor further proposes that part of the new fund shall be appropriated to the enlargement of the buildings of the Institute at Chelsea, part to increasing the at present sadly inadequate salaries of the Director and other members of the scientific staff, part to the expenses of administration and maintenance, and the remainder chiefly to founding valuable fellowships and studentships, tenable for limited periods, for research either in the laboratories of the Institute or in centers of outbreaks of disease, whether at home or abroad.

The conditions on which these fellowships and studentships may be held are not yet determined upon, but it is hoped to open them to all classes of her Majesty's subjects.

Lord Iveagh, in our opinion, deserves the gratitude of the nation for thus munificently providing for the cultivation, in the British dominions, of biology and allied sciences for the good of mankind in an institution which henceforth will compare favorably with any similar establishment in other parts of the world.

It will be remembered that the British Institute of Preventive Medicine received from the Jenner Memorial Committee the funds that it had collected and altered its name in honor of Jenner. It has recently taken possession of new buildings on the Chelsea Embankment. Dr. Allan Macfadyen is the Director.

Lord Iveagh has at the same time undertaken to rebuild the most unhygienic district of Dublin, erecting upon it model workmen's dwellings, recreation halls, etc. The cost of the improvements are estimated at over £250,000.

GENERAL.

PROFESSOR B. K. EMERSON, of Amherst College, has been elected President of the American Geological Society in succession to Professor J. J. Stevenson, whose address on 'Our Society' is published in the present number of SCIENCE.

THE American Society of Naturalists at its recent meeting appropriated \$50 towards the support of the American University Table at Naples, and \$50 towards the support of the Naturalists' Table at the Marine Biological Laboratory at Woods Holl. It was voted that the place of the next meeting be left with the Secretaries of the several societies, who will probably select New Haven. The following is a full list of the officers for the ensuing year: President, W. G. Farlow; Vice-Presidents, H.

C. Bumpus, W. H. Howell, F. H. Gerrish; Secretary, T. H. Morgan; Treasurer, John B. Smith; Members of the Executive Committee elected from the Society-at-large, Bashford Dean, F. H. Herrick.

At the annual public meeting of the Paris Academy of Sciences, on December 19th, the Permanent Secretary, M. Berthelot, read a memorial notice of Brown-Sequard, the eminent physiologist, who, it will be remembered, was the son of a citizen of Philadelphia. Brown-Sequard led a life full of vicissitudes, crossing the Atlantic more than sixty times, until in 1878 he was elected Professor in the University of Paris and was naturalized as a citizen of France. The President of the Academy, M. Wolf, called attention to the approaching bicentennial of the Academy and paid tributes to the members who had died during the year: MM. Aimé Girard, Souillard, Pomel and Cohn, of Breslau.

At the same meeting of the Academy the prizes for the current year were awarded. Three of these, as we have already announced, were given to Americans—the Lalande prize to Dr. Seth C. Chandler, the Damoiseau prize to Dr. George W. Hill and the Henry Wilde prize to Mr. Charles A. Schott. Another prize, the Lallemand prize, was divided, and one half given to Mr. Edward P. Allis, of Milwaukee, Wis., for his memoir on 'The cranial muscles and cranial first spinal nerves of *Amia calva*.' In addition to these four prizes coming to America, apparently only two other prizes were given outside of France—the Janssen medal to A. Belopolsky, of the Observatory at Pulkova, for his contributions to astronomy, and the Desmazière prize to Professor de Toni, of Padua, for his *Sylloge Algarum*.

THE Academy offered in all about fifty prizes, the largest of these, the Bréant prize, of 100,000 fr., was in part given to M. Phisalux for his researches on chemical vaccines. The LeConte prize, of 50,000 fr., for an important scientific discovery, was not awarded. The grand mathematical prize (6,000 fr.) was awarded to M. Morel, and the Poncelet prize (2,000 fr.), also in mathematics, to M. Hadam. The Jecker prize in organic chemistry (10,000 fr.) was di-

vided among MM. Bertrand, Buisine and D. Berthelot. The Vaillant prize in geology (4,000 fr.) was given to M. Cayeux, and the Estrade-Delcros prize (8,000 fr.) to M. Munier Chalmas for his work on paleontology and geology.

PROFESSOR WILLIAM RAMSAY gave an address before the German Chemical Society, Berlin, on December 20th, describing the newly discovered gases and their relation to the periodic law. He also gave a popular lecture on the subject.

MR. SYDNEY ROWLAND has been appointed Assistant Bacteriologist at the Jenner Institute of Preventive Medicine.

M. TROOST has received an anonymous gift of 4,000 fr. for researches on the liquefaction of air.

THE Honorable R. J. Strutt, who, as we recorded last week, has been awarded the Coutts-Trotter Studentship in Science at Trinity College, Cambridge, is a son of Lord Rayleigh, the eminent physicist, formerly professor at Cambridge University.

DR. ALFRED A. KANTHACK, professor of pathology in the University of Cambridge and Fellow of King's College, died at Cambridge, on December 21st, at the early age of thirty-five years. Dr. Kanthack was elected to the professorship in Cambridge a little more than a year ago, succeeding the late Professor Roy. He is the author of a 'Manual of Morbid Anatomy' and of a 'Hand-book of Bacteriology' and of numerous and important original contributions to these sciences.

WE regret also to record the death at Philadelphia, on January 5th, of Dr. E. Otis Kendall, in his eighty-first year. He had been for more than fifty years professor of mathematics in the University of Pennsylvania, though recently he had relinquished active duties. He had also held the chair of astronomy in the University, was long dean of the scientific department, and was in 1883 elected vice-provost, being honorary vice-provost at the time of his death. Dr. Kendall was for twenty-eight years one of the Secretaries of the American Philosophical Society, and for the following twenty-one years one of its Vice-Presidents. He was the author of a text-book of astronomy and of

various contributions to mathematics, as well as of computations for the U. S. Nautical Almanac and the U. S. Coast and Geodetic Survey. Dr. Kendall will, however, be best remembered as a teacher, being greatly honored and beloved by many generations of college students.

THE death is also announced, at the age of sixty-four years, of Professor H. W. Vogel, of the Institute of Technology at Berlin, known for his researches in photography and spectroscopy.

GROUND for the Horticultural Hall of the New York Botanical Gardens was broken on January 3d. The building will be 512 feet long, 60 feet wide, with a dome 90 feet high.

THE following lectures will be given during the present season at the American Museum of Natural History at three o'clock on Saturday afternoon.

- Jan. 7.—An Exploration for Dinosaurs in the Rocky Mountain Plateau Region..DR. J. L. WORTMAN.
- Jan. 14.—A Hunt for Fossil Camels and Horses in Kansas and Colorado.....DR. W. D. MATTHEW.
- Jan. 21.—The Bird Rocks of the Gulf of St. Lawrence.....MR. FRANK M. CHAPMAN.
- Jan. 28.—Exploration of Zapotecan Tombs of Southern Mexico.....MR. M. H. SAVILLE.
- Feb. 4.—The Jesup North Pacific Expedition: Archaeological Exploration in British Columbia,
MR. HARLAN I. SMITH.
- Feb. 11.—The Jesup North Pacific Expedition: The Indian Tribes of the State of Washington,
DR. L. FARRAND.
- Feb. 18.—Rocks of the State of New York as illustrated in the Museum.....MR. L. P. GRATACAP.
- Feb. 25.—A Collecting Trip in Europe,
DR. E. O. HOVEY.
- Mar. 4.—The Squirrels of North America,
DR. J. A. ALLEN.
- Mar. 11.—The Life Histories of Butterflies and Moths of the Vicinity of New York,
MR. WM. BEUTENMÜLLER.
- Mar. 18.—The Hyde Expedition: Exploration of the Ruins of the Pueblo of Bonito, New Mexico,
MR. GEORGE H. PEPPER.
- Mar. 25.—Peoples of Asia—The Philippines to Japan,
PROFESSOR ALBERT S. BICKMORE.

On Thursday evening at eight o'clock lectures will be given as follows:

The New York Zoological Society.

- Jan. 12.—The Zoological Parks of Europe and The New Zoological Park of New York City
PROFESSOR HENRY FAIRFIELD OSBORN.

Linnean Society of New York City.

- Jan. 19.—A Naturalist in Florida
FRANK M. CHAPMAN.
Jan. 26.—A Naturalist in Labrador
DR. ROBERT T. MORRIS.
Feb. 2.—A Naturalist on the Pacific Coast
DR. BASHFORD DEAN.
Feb. 9.—A Naturalist in Wyoming
ERNEST SETON THOMPSON.

New York Botanical Garden.

- April 6 and 13.—Subjects and lecturers to be announced later.

Members' Course—1899.

PROFESSOR ALBERT S. BICKMORE, Curator of the Department of Public Instruction.

- Feb. 16 —Newfoundland and Labrador.
Feb. 23.—Gulf and River of St. Lawrence.
Mar. 2.—The Great Lakes.
Mar. 9.—Central California—San Francisco and Yosemite Valley.

PROFESSOR A. C. HADDON writes to *Nature* that the members of the Cambridge Anthropological Expedition to Torres Straits have now completed their investigations in the Straits. Dr. Rivers and Mr. Wilkin have left for England, while the other members of the expedition have proceeded to Borneo to study the anthropology of the Baram district of Sarawak. The health of the party has been excellent. The natives of Murray Island were studied with most detail, as, owing to their isolation, they have been less modified by contact with alien races. Some of the party stayed about four months on the island, while others had only a couple of months, owing to a trip having been made to the mainland of New Guinea. The New Guinea contingent visited the coast tribes between Kerepunu and the Mekeo district, and several excursions were made for short distances inland. There was not enough time spent at any spot for a thorough investigation of the natives, but a considerable amount of information was obtained in most of the branches of anthropology with which the expedition is concerned, which will prove of value for purposes of comparison. The researches on the Murray islanders were fairly thorough and will form a basis for comparison with the other islanders and allied peoples. Over a month was spent in Mabuiag (Jervis

Island) by all the party, with the exception of Messrs. Myers and MacDougall, who had previously started for Borneo. Although the time spent in Mabuiag was short, a satisfactory amount of work was accomplished owing to the conditions being favorable. Observations were also made on several other islands in Torres Straits and Kiwai, which is situated in the mouth of the Fly River. A large number of photographs have been taken, and considerable collections have been made, which are now on their way to Cambridge.

In a recent address before the British Ornithologists' Club Mr. Sclater, after referring to the expedition to Socotra and southern Arabia, with Dr. Forbes and Mr. Ogilvie Grant as its leaders, referred to other expeditions of British ornithologists. Captain Boyd Alexander, who has worked in the Cape Verde Islands, is struggling through the middle of Africa from the Cape to Cairo. Under present circumstances he seems likely to come out successfully, and will, no doubt, bring information on birds, if not specimens, with him. Mr. Lort Phillips hopes to return to his favorite quarters in Somaliland during the course of the present winter, and expects to get together the supplementary materials still required for the preparation of his proposed work on the birds of that most interesting country. Mr. John Whitehead, who has added so much to our knowledge of the zoology of the Philippines, proposes to return to the same country very shortly, in order to continue his researches in a field which he knows so well and in which he takes such great interest. Mr. Alfred Sharpe, C.B., who is shortly returning to his post in Nyassaland, promises to continue the employment of collectors in different parts of that Protectorate, the zoology of which he, following in the footsteps of Sir Harry Johnston, has already done so much to investigate.

We learn from the *British Medical Journal* that an International Congress on Tuberculosis and the methods for combating it will be held in Berlin from May 23d to 27th next year. The Imperial Chancellor, Prince Hohenlohe, will preside, and will be supported by an influential committee, headed by the Duke of

Ratibon and Professor von Leydon. Five divisions of the subject have been agreed on: (1) Propagation, (2) Etiology, (3) Prophylaxis, (4) Therapeutics, (5) Sanatoria. Each of these questions will be introduced by a short and concise address, so as to leave ample time for free discussion and debate. Membership of the Congress is not to be confined to any particular class; any person interested in that terrible scourge of all nations, tuberculosis, can become a member by simply taking a ticket at the office of the Central Committee for Lung Sanatoria. As in the case of the Leprosy Conference a couple of years ago, foreign governments will be officially informed of the proposed Congress and requested to send delegates.

THE Berlin correspondent of the London *Times* states that the official organ of the Prussian Ministry of the Interior gives some account of the work accomplished since its constitution three years ago by the German Central Committee for the establishment of sanatoria for consumptives under the protection of the German Empress and the presidency of the Imperial Chancellor, Prince Hohenlohe. The great object of the Central Committee was to promote the establishment of a sufficient number of sanatoria throughout the German Empire. Their efforts have been most successful, owing to the cooperation of wide circles of the public, and more particularly owing to the measures taken by the Imperial German Working People's Insurance Office in providing hospitals and convalescent homes for those of the insured who are attacked by illness and prevented from earning their living. A large number of sanatoria which are already receiving patients have demonstrated that Germans who suffer from tuberculous diseases do not require to go abroad in search of health, but can secure the best medical treatment in the immediate neighborhood of the place where they have to live and work. There will presently be some 50 sanatoria in Germany for persons in straightened circumstances. The Central Committee has cooperated in various degrees in the development of these institutions by placing at their disposal information and, where it was requisite, by making grants for their support. It has thus been found possible, while consulting in every

case the special nature of local necessities, to establish the institution of sanatoria for consumptives in Germany on a sound and permanent basis. A meeting of the Central Committee, at which Her Majesty, the Empress, will be present, will be held on January 9th. President Gäbel, of the Imperial Insurance Office, will make a report on the new rules to be adopted, the object of which is to extend the sphere of the Committee's operations on the lines which they have hitherto followed.

UNIVERSITY AND EDUCATIONAL NEWS.

AT the twenty-seventh convocation of the University of Chicago, on January 4th, President Harper announced two gifts of land, one by Mr. N. A. Ryerson, valued at \$34,000, and one by Marshall Field, valued at \$135,000. A gymnasium will be erected on the latter site. The enrollment of the University is 1,621, an increase of 450 over last year.

MR. H. O. ARMOUR has given \$20,000 to Whitworth College, a Presbyterian institution at Sumner, Wash. The sum of \$75,000 has been collected for Arcadia University, a Baptist institution at Wolfville, N. S., \$15,000 having been given by Mr. John D. Rockefeller.

THE alumni of Harvard College, by a vote of 2,782 to 1,481, have reversed their previous vote extending the franchise in voting for overseers of the University to the graduates of all the schools. President Eliot and most members of the faculty who are alumni voted with the minority.

THE annual catalogue of Harvard University records 411 officers and 4,660 students, an increase of 7 officers and 84 students over last year. These figures include the summer school, but not Radcliffe College, the enrollment of which is 411 students. There are 1,851 students in the College and 560 in the medical school.

THE new catalogue of the University of Pennsylvania, about to be issued, will show that there are 258 officers and 2,790 students, of whom 1,337 are in the departments of medicine and dentistry. There are in the School of Arts 365, in the Towne Scientific School 284 and in the Department of Philosophy 158 students.

SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; J. LE CONTE, Geology; W. M. DAVIS, Physiography; O. C. MARSH, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; HENRY F. OSBORN, General Biology; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; J. MCKEEN CATTELL, Psychology; DANIEL G. BRINTON, J. W. POWELL, Anthropology.

FRIDAY, JANUARY 20, 1899.

CONTENTS:

<i>Advances in Methods of Teaching:—</i>	
<i>Zoology</i> : PROFESSOR EDWIN G. CONKLIN.....	81
<i>Anatomy</i> : PROFESSOR GEO. S. HUNTINGTON....	85
<i>Physiology</i> : PROFESSOR WM. T. PORTER	87
<i>Psychology</i> : PROFESSOR HUGO MÜNSTERBERG ..	91
<i>Anthropology</i> : DR. FRANZ BOAS.....	93
<i>Botany</i> : PROFESSOR W. F. GANONG.....	96
<i>Eleventh Annual Meeting of the Geological Society of America (I.)</i> : PROFESSOR J. F. KEMP.....	100
<i>Scientific Books:—</i>	
<i>Burnside's Theory of Groups of Finite Order</i> : PROFESSOR F. N. COLE. <i>Merriman's Elements of Sanitary Engineering</i> : M. Card on Bush Fruits: PROFESSOR BYRON D. HALSTED. <i>Hill and Vaughan on the Lower Cretaceous Gryphæus of the Texas Regions</i> : PROFESSOR FREDERIC W. SIMONDS. <i>Books Received</i>	106
<i>Scientific Journals and Articles</i> :.....	111
<i>Societies and Academies:—</i>	
<i>The National Geographic Society; Harvard University, Students' Geological Club</i> : J. M. BOUTWELL. <i>Onondaga Academy of Sciences</i> : H. W. BRITCHER. <i>The Academy of Science of St. Louis</i> : PROFESSOR WILLIAM TRELEASE	112
<i>Discussion and Correspondence:—</i>	
<i>Science and Politics</i> : PROFESSOR S. W. WILLISTON. <i>The Storing of Pamphlets</i> : PROFESSOR CHARLES S. CRANDALL. <i>Zone Temperatures</i> : DR. C. HART MERRIAM.....	114
<i>Physical Notes</i> : F. C. C.	116
<i>Current Notes on Meteorology:—</i>	
<i>The Windward Islands Hurricane of September, 1898; Probable State of the Sky along the Path of the Eclipse, May 28, 1900; Notes</i> : R. DEC. WARD.....	116
<i>Current Notes on Anthropology:—</i>	
<i>The Oldest Skull-form in Europe; The Supposed 'Otter Trap'; Anthropological Study of Feeble-minded Children</i> : PROFESSOR D. G. BRINTON..	117
<i>Scientific Notes and News</i>	118
<i>University and Educational News</i>	120

MSs. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

ADVANCES IN METHODS OF TEACHING.* ZOOLOGY.

By *advances in teaching* I understand the use of desirable methods not now generally employed, for while the common methods of this generation are advances over those of a preceding one a discussion of this fact could have no possible value and only an historical interest to us.

I take it that the common method of teaching zoology is by means of laboratory work supplemented by lectures or recitations, and, further, that both teacher and institution are well equipped for this work; these are prerequisites, the need of which need not be emphasized here. Beyond and in addition to these common provisions what advances in teaching zoology are both possible and desirable? Many minor features might be considered, such as certain improvements in laboratory and museum methods, the best sequence of subjects, the relations of lectures to laboratory work, etc.; but I prefer to emphasize two, and only two, main features, viz.: (1) the relations of research to teaching, and (2) the study of the whole of zoology.

I. One of the greatest possible advances in teaching zoology would be the promotion of research work in all institutions of college or university grade and the establishment of the closest possible relations be-

* Discussion before the New York meeting of the American Naturalists and Affiliated Societies, December, 1898.

tween teaching and research. Advances in teaching must be, in the main, founded upon advances in research. Objects which every beginner in zoology sees and studies to-day were known to only a few investigators ten years ago. Methods which are common property now were then being worked out for the first time. The interest and value of teaching is directly proportional to the teacher's acquaintance with original sources of knowledge. The all too common method of leaning—or rather riding—upon a text-book violates the whole laboratory idea, and the more advanced custom of relying upon original papers without making any attempt to see the things described is but little better. Every teacher should endeavor to see and know for himself, and to give his students opportunity to see and know the classical objects upon which important doctrines of zoology rest.

But the relation of the teacher to research should not be merely that of a *hearer* of the word, but of a *doer* also. Research work on the part of the teacher and, if possible, by at least a few advanced students should be a part of the *teaching equipment* of every college and university. Too frequently and indiscriminately has it been maintained that the qualities which make a man a good investigator ruin him as a teacher. The examples of Agassiz, Huxley, Leuckart and many others, both here and abroad, show how erroneous is such a view. Great ability as an investigator may be united with qualities which are ruinous to the teacher, but these are not qualities essential to research. On the other hand, a good teacher must be, at least to a certain extent, an investigator also. The ability to make a subject plain is not the first nor, indeed, the most important function of a college or university teacher; his first duty is to arouse interest in his subject, to direct students to reliable sources of information and to encourage them in independent work. For all of these

purposes research is of the utmost value. A new fact discovered in a laboratory is a stimulus to faithful and independent work, such as nothing else in the world can be; whatever other requirements colleges and universities may make upon their teachers, they might safely require that they be contributors to knowledge. The greatest mistake which a college or university teacher can make is to talk and act as if his science were a closed and finished one. A subject which seems old and stale to the teacher will seem uninteresting and unimportant to the learner. To the teacher who has only a text-book knowledge of things all subjects soon seem finished, fixed, bottled and labelled; once a year, perhaps, he wearily exhibits these dead and changeless things before his suffering class. But the teacher who realizes how little we know about any subject and how much remains to be learned—who, while accurately presenting what is known, can by both precept and example help to extend the bounds of knowledge—will never find his subject stale nor his class uninterested.

It will be objected that in many subjects and in most institutions such a course is impossible. Undoubtedly it is more difficult to make discoveries in some fields than in others, but it is one of the particular charms of the biological sciences that the opportunities for research here are greater than in most other subjects. The great amount of teaching and of administrative work which is required of many teachers is the greatest obstacle to this plan; and yet I know persons who teach from twenty-five to thirty hours a week and who yet find time to do research work, if in no other way, at least by keeping their eyes open for new points in the material used in their classes.

It is sometimes maintained that there is a fundamental difference in kind between graduate and undergraduate teaching, and

that the former alone can have any relations to independent work or research, while the latter must consist of information courses merely. But whatever may be true of other subjects, it is certain that biological studies encourage and develop independence in observations and reflections from the beginning. I maintain, even at the risk of being charged with holding low ideals of graduate work, that the distinction between graduate and undergraduate work in biology is one of degree and not of kind. Of course, elementary students cannot do research work of any great value, and yet they may catch the spirit of research and assist in carrying out work of importance. Some valuable work of the last few years has grown out of the careful and independent study, in undergraduate classes, of the structure, development and variations of well-known animals. The knowledge that new facts may be discovered even in elementary work is an inspiration to both student and teacher. I pity the man who has to teach a finished science; I wonder how either he or his students stand it. The zoologist has here an advantage which he cannot afford to throw away. If it is further objected that this method would induce students to neglect well-known facts in ridiculous attempts to find new ones, or that it would assist an ignorant or lazy teacher to fill up gaps in his information by ingenious speculations, I can only reply that such an abuse should be credited to the teacher and not to the system. The thesis which I defend is simply and comprehensively this: The spirit of zoological teaching should be the inquiring, independent, alert spirit of research.

II. Another advance not less important than the one just emphasized would be found in increased facilities for studying the whole of zoology. The time was when zoology meant merely classification; at present it means little more than morphology; a great

advance will have been made we all realize, and succeed in getting our institutions to realize, that these subjects, however important, are but a part of zoology and that a large and important field is still almost unoccupied. The usual laboratory work in zoology, viz.: the anatomy of a few alcoholic specimens, is less than one-half of the science and in all respects the least interesting and important half. Research to-day is tending more and more to the study of *living* things, and in this respect, as in so many others, research points out the way for advances in teaching. The study of living animals; of their actual development under normal and experimentally altered conditions; of their food and the manner of getting it; their enemies and friends, parasites and messmates; their mating, breeding and care of young; the effects of isolation, crossing and close breeding on structure and habits; the effects of varying light, color, temperature, density of medium, etc., on color, size and structure of every part; the daily and nightly activities of animals; the origin and nature of peculiar habits and instincts—in short, the study of all the varied ways in which animals live and adapt themselves to their environment is an integral part of zoology; and who can doubt that together these things form its most important part, and yet there are few if any places where any systematic attempt is made to give instruction in these subjects.

Practically the only attempt which is made in most institutions to meet these needs is by means of field work. The value of such work cannot be overestimated and it must always remain an indispensable part of any broad zoological training, but it is not in itself sufficient. In large cities and during the colder part of the year it is especially difficult to carry on field work, and in no case is it possible to have animals under observation for considerable periods

of time or to carry on experiments with them in the field. Field work must consist largely of collection, classification and scattered observations; more serious work must be transferred to the laboratory.

A most useful and important adjunct to zoological teaching is an animal house, or vivarium, in which may be found fresh and salt-water aquaria; terraria for small land forms; hives for bees, ants and other insects; rooms for various amphibia, reptiles, birds and small mammals; hatcheries for the eggs of various vertebrates and invertebrates, and various appliances for the experimental study of living animals. Such a vivarium might contain a synoptic collection of living animals, worth vastly more for teaching purposes than the ordinary museum or laboratory. Botanists have long recognized the necessity of greenhouses for teaching purposes, and the need of having living material for study is quite as great in zoology as in botany. Some such vivarium is a necessity if zoology is to be studied in any broad way. It is usual in building laboratories to provide an animal room in some small, dark corner of the cellar, while the whole of the building proper is devoted to lecture rooms, laboratories and museums. It is sad to think that such a disposition of space represents the popular view of the importance of the study of living animals. In a very important sense a vivarium is the most essential part of any laboratory of zoology, representing that for which all the rest exists. In cases where it is not possible to have a separate building or large, well-lighted rooms for this purpose a greenhouse and animal house could be combined; and in all cases a few well-stocked ponds in the immediate vicinity of the laboratory can usually be provided without trouble or expense, which will furnish a never-failing supply of living material.

But under the most favorable circumstan-

ces the number of living animals which can be kept in or near the laboratory is not large; for making extensive studies on large numbers of animals, recourse must be had to experimental farms and to marine and fresh-water stations. Little has yet been done in the way of establishing experimental farms for purposes of pure science, though I believe they are destined to play a very important part in the development of our science in the future, but the establishment of biological stations has done more to advance the study of zoology than any other one thing in this generation. While the laboratory, the vivarium and perhaps also the experimental farm are things which each university must provide for itself, the marine and fresh-water stations can reach their greatest usefulness through the cooperation of many institutions. Without in any way disparaging the work done by other stations of a similar kind, I think it may truthfully and modestly be said that the Woods Holl Station, in the measure of cooperation which it represents; in the close relations which there exist between teaching and research, and in the fullness with which the whole of zoology is represented, has done more to advance the teaching of zoology in this country than has any other institution or factor. The professor of anatomy in one of our best medical schools said to me a few days ago: "In all my teaching I try to follow the general methods employed in the classes at the Woods Holl Laboratory; those methods are models of good teaching." If this can be said for the teaching of human anatomy how much more is it true of the studies which are there directly represented. Some of the greatest possible advances in teaching zoology will be found in realizing in every college and university the Woods Holl ideal.

EDWIN G. CONKLIN.

UNIVERSITY OF PENNSYLVANIA.

ANATOMY.

It is not too broad a statement to say that the modern methods of teaching anatomy reflect the general progress of that science during the past decade. In the limited time at my disposal I am only able to accentuate some of the main facts as they pertain to instruction in human anatomy. In this branch the revolution in the spirit and method of our teaching is primarily based on the recognition of man's scientific position in the vertebrate series. We have ceased, as teachers, to regard the human body as a thing apart and by itself, and the study of its structure and of the functions of its parts is no longer attempted without the aid which comparative anatomy and embryology so abundantly offer. The truths embodied in the doctrine of evolution have long furnished the quickening spirit of scientific morphological study and research, but their full utilization by the teacher of human anatomy as his most valuable guides is of so comparatively recent date that I feel justified in citing their pedagogic adoption as the most important and fundamental advance in late years in the methods of anatomical instruction.

It is so evident that every complete organism is only fully comprehended in all its relations when the method of its production and development is known, and the fact that the simplest conditions offer the logical starting point in learning or teaching complicated structural details is so in accord with our daily experience, that the disregard of phylogeny and embryology by teachers of human anatomy seems little short of incomprehensible. And yet in my own experience as a teacher of human anatomy I remember grave academic deliberations as to the propriety of placing the study on the scientific basis which we occupy to-day, and some doubtful queries as to whether after all it would not be more advisable to uphold the traditional method, somewhat as the Mos-

lem Kadis have continued to teach the Koran since the day of Mahomet. Human anatomy, considered from the standpoint of the instructor, has coursed through a curious cycle since Vesalius in the 14th century raised it to the dignity of a science.

From the point where he left it the knowledge of man's structure continued to develop during the succeeding centuries. The details of human gross anatomy were elaborated until every minute portion of the human frame received its complete description, and at least one more or less appropriate and lengthy name. The teaching of the science progressed along the same lines, and the increase in the details of descriptive anatomy found its response in the anatomical text-book. Edition succeeded edition, each containing somewhat more erudite and minute information than its predecessor, and this accumulated mass of facts confronted the student at the outset of his course. It is not remarkable that under these conditions the important fundamental structural lines of the subject were obscured and overshadowed by the quantity of detail, nor that the study of anatomy appeared to resolve itself into a more or less successful effort at memorizing the largest possible quantity of facts without special regard to their quality or importance.

I well remember in my own student days that every man with any pretensions to anatomical prowess could glibly and accurately describe the five surfaces of the orbital process of the palate bone and give their boundaries, but I doubt if many of us realized that said process was extremely lucky if it attained the size of a respectable pea, and a still smaller minority would have passed with credit through a practical demonstration on the skull. In the same way the knowledge that the artery of the vas deferens arises from the superior vesical was a never-failing source of satisfaction to

its possessor, while a student who faced west on Madison Square had no occasion to strain his descriptive faculties in the least in order to enumerate the Fifth Avenue Hotel in its correct position among the structures related to his common carotid artery. But the morphological connection and the mutual relation existing between prosencephalon and diencephalon, the principles governing the development and structure of the lung and vascular system, the disposition of the peritoneal membrane, and many like problems, were regarded in much the same light.

What knowledge of these structures the student obtained he gained in the most difficult manner, by a pure effort of memory. He had no constructive details at his command, no series of stages which, while demonstrating the road by which a complicated human structure reached its highest degree of development or regression, enabled him at the same time to grasp and hold the details of that structure as a permanent and lasting addition to his knowledge, not as facts memorized and hence to be forgotten. In this sense teaching by comparison and development marks our most important and fundamental advance in methods of instruction. That this advance will be progressive lies in the very essence of its character. We all recognize the practical importance of careful descriptive detail in teaching human anatomy. But in striving after the necessary accuracy and elaboration the minutiae should not be permitted to obscure and hide the broad morphological and functional principles which underlie the construction of the animal body.

They, after all, form the fundamental lines upon which the student must build his anatomical knowledge if the same is to be enduring, and these lines, if once firmly established, readily and logically permit the addition of the necessary details. The function of comparative anatomy and em-

bryology, as aids in the teaching of human anatomy, is to define clearly and demonstrate, beyond question or doubt, the cardinal morphological principles upon which the structure of the vertebrate body is reared. I can merely refer in passing to the development of the equipment necessary to the vitality and success of the method. Perhaps no other single fact accentuates the advances in morphological education more than the change which is to be observed in the spirit and purpose of the anatomical museum. It has ceased to be a storehouse for a heterogeneous association of curios, and has assumed its proper place as an important factor in scientific education, presenting the cardinal structural and functional principles of the vertebrate body in concrete serial form. From a collection it has become a library in which he who runs may read.

While we are justified in characterizing this fundamental change in the spirit and conception of anatomical instruction as our most pronounced methodical advance in recent years, a number of other improvements are entitled to your consideration. Hardly secondary in importance to the principle of the comparative and developmental method of teaching is the application of the principle in practice. I need not detain this audience with illustrative examples, which will suggest themselves, but I may be permitted to emphasize the fact that we have advanced materially in substituting true object-teaching for theoretical instruction. Perhaps nowhere more than in anatomy is lasting and valuable knowledge gained only by direct and personal examination of the object of the study.

Not only have our courses in practical anatomy increased in the time and material required and improved in the application of a thorough test by practical examination, but we have carried the same cardinal principle of sound anatomical instruction into

the details of the didactic course. It is probably true that, under proper conditions of environment, a parrot could be taught a hymn, for we have proof of his power in acquiring a secular vocabulary. In the same way, undoubtedly, a student can be taught a certain kind of anatomy by lecture, diagrams and models. But I question whether he will find this knowledge much more useful than the parrot his hymn. Assimilation of anatomical knowledge requires demonstration of the actual structures, to a limited number of students, for the purpose of enabling each to see and examine the objects themselves with which he is to become familiar, not models or diagrams. "I asked for bread and they gave me a stone"—or a model—is a saying which no student of anatomy should have occasion to apply to his own case.

This reason has led to the replacement of the didactic lecture by the section demonstration. I still concede to the lecture, modified and supplemented by demonstration, an important function in furnishing the orderly, logical and systematic presentation of the subject which is to serve as the guiding thread in the student's individual examination of the structures. It is the proper place for the elaboration of the broad morphological principles of vertebrate structure, but these should be illustrated and emphasized by the direct examination of the structures involved. The lecture should indicate clearly the main facts of which the student is to satisfy himself by personal observation in the demonstration. Both conducted side by side are mutual supplements.

Such, in brief, I conceive to be the main factors in the advance of anatomical teaching. Many secondary aids, such as the complete pedagogic separation of elementary and advanced students, the modern methods of preservation of material, the improved technique of preparations, the intro-

duction of elective and optional courses in general morphology and others would demand consideration if more time were at our disposal.

But, however brief and insufficient my presentation of the subject may appear, teachers of anatomical science feel that the advance along the lines indicated is a material gain and that, under the broad spirit of our universities, it will be progressive.

GEO. S. HUNTINGTON.

PHYSIOLOGY IN MEDICAL SCHOOLS.

THE paper which I have had the honor of preparing for this occasion consists of three parts; the first gives a critical review of the present unsatisfactory methods of teaching physiology in medical schools (in which institutions most of the physiological teaching is done); the second presents a detailed proposal for instruction in accordance with what are believed to be correct pedagogical principles; and the third discusses ways and means, and demonstrates that the proposed changes are within the present means of any successful school. The time allotted to each speaker requires the omission of the critical account of present methods and the discussion of ways and means. Only the second part of the paper can be given here.*

The picture I have drawn of the instruction in physiology in medical schools will not be challenged by teachers of that science. The sense that our methods of instruction neither develop nor much inform the mind is general. It is time that discussion of the difficulties and the way to remedy them should also be general. Physiology is the most highly developed rational discipline in medicine—not a merely descriptive science like anatomy and is well adapted to train the mind in scientific procedure, in the setting of problems for research, in the

* The full paper is printed in the *Boston Medical and Surgical Journal*, December 29, 1898.

criticism of methods and results, and in the tests which lay bare shallowness—matters of great moment to men who shall practice an applied experimental science in the midst of quackery, illusion and pretence. Careful inquiry should therefore be made to determine how far defects of instruction can be remedied with the means at our disposal. The problem is: How far can the correct theory be realized in practice? To what extent can medical students of physiology be taught in the manner in which men are trained to be professional physiologists? Evidently physiologists are likely to study their own subject in the most profitable and labor-saving way.

Much can be done to reconcile theory to practice, but not everything. The size of physiology has broken it into specialties. Even professional physiologists can no longer have personal acquaintance with the whole subject or even a relatively large part of it. The truth of this will be obvious when it is remembered that since January 1, 1894, more than three hundred researches have been published on the physiology of the heart alone. To a considerable degree the physiologist himself must acquire his information from reading the work of others. It would therefore be idle to expect the student of medicine to get a personal experimental knowledge of the whole subject. He has but a year for physiology and must share that time with anatomy. Grave economic laws demand this time shall not be lengthened, and the day of self-support postponed. The time which he now has must be used chiefly for training and not chiefly for the acquisition of facts, as at present, and this training must follow the lines laid down by physiologists for their own development.

The way of the physiologist is not peculiar. The method of getting a real education is the same from the kindergarten to the specialist. The principle is to train 'for

power,' to use President Eliot's phrase, and not primarily for information. Deal so far as possible with the phenomena themselves and not with descriptions of them. Use as the basis of professional instruction the facts and methods which shall be used by the student in earning his living. Teach the elements by practical work. Associate facts which the student can observe for himself with the facts which he cannot observe. Control the progress of the student, remove his difficulties, and stimulate him to collateral reading by personal intercourse in the laboratory, by occasional glimpses of the researches in progress in the laboratory, and by daily conferences or seminars. Give the student careful descriptions of the method of performing his experiments, but require him to set down the results for himself in a laboratory notebook, which, together with the graphic records of his experiment, is to form a requirement for the Doctorate. Choose one sufficiently limited field in which experimental work shall be thorough and comprehensive, affording a strong grasp of that special subject. Add to this the typical, fundamental experiments in other fields.

When the student has come thus far, let him choose one of several electives affording advanced training in the physiology of the medical specialties, such as ophthalmology, laryngology, the digestive tract, the nervous system, etc. These courses should be thorough, should contain the physiology required of the best specialists, and above all should deal with nature directly. For example, in studying the physiology of the stomach, the gastric juice should be taken with the stomach-tube directly from the human object, and not obtained merely by adding hydrochloric acid to scrapings of the mucous membrane of swine. This special instruction should be directed by distinguished specialists. Thus the student will be brought into contact with that which will

interest him most, the every-day methods of the best physicians, and the specialist will keep his own foundations in repair. It is in connection with these courses that didactic lectures should be given. Up to this point in his work the student is not ripe. Let there be one to four lectures of not more than forty-five minutes, the subject very limited, so that each set shall present all the existing knowledge on the subject. The purpose of these lectures is to show the student the historical development of scientific problems, the nature of scientific evidence, and the canons of criticism that shall help him to sift the wheat from the chaff of controversy. Lectures of this kind cannot profitably be given by men who have not made experimental investigations in the subject of the lecture; so far as practicable they should be given by the specialists who advise the physiological staff concerning the special courses.

Each student should be required to present one written discussion of some very small and sufficiently isolated thesis, giving the work of the original investigators, together with any observations the student has made for himself. The way of dealing with the sources at first hand will thus be learned.

The student's reading should be correlated strictly with his practical work and should be done in the laboratory in connection with that work. It should not be memorizing, as at present, but the study of graphic records, physiological-anatomical preparations and other physiological material, with the aid of the text-book. The corrections necessary to bring the book up to date and to correlate it with the practical work can be furnished in printed or mimeographed notes.

Such are the lines along which sound theory directs that the teaching of physiology in medical schools should proceed. With such a training the student can safely

find his way through the constantly augmenting horde of facts and draw vicarious profit from those who are face to face with the mysteries of nature. Such instruction meets also the needs of men intending to make a profession of biological sciences other than medicine. It will be observed that the course offers: (1) thorough experimental acquaintance with one field, say the physiology of nerve and muscle, giving the point of view, the general physiological method, training in technique, a basis of analogy, adequate knowledge of one living tissue and thus the elements of all; (2) the fundamental elementary experiments in the remaining fields; with the key which the first course gives, these will unlock much; (3) thorough experimental acquaintance with one special subject; (4) various complementary gains, of which may be mentioned experience in reaching the original sources and in marshalling facts, a certain degree of skill in the methods used by practitioners, direct correlation between physiology and practical medicine. Much might be said of the value of this group, particularly of the correlation just mentioned, but we must hasten on to the demonstration of how these ends are to be attained practically.

The first problem to be solved in planning instruction is whether the student's time is to be given wholly or only in part to the subject taught. Men in training for professional physiology commonly concentrate their energies for a sufficient period on this one subject, and this is regarded as the most economical way of mastering any science, for the ground gained by one day's work is still fresh in the mind when the next day's work begins, and continuity of thought is not disturbed. The plea that the instruction in one subject should be broken by the injection of other subjects in order that the instruction in each may have 'time to sink in' need not be entertained;

experience shows that much of it sinks in so far that it cannot be got up again without the loss of valuable energy. A more serious objection is that the method of continuous application is highly fruitful in the case of men of exceptional powers, who are keen in spite of protracted effort, but is wasteful for the average brain, which is fatigued and unreceptive after some hours of unremitting labor. The truth of this must be allowed, but the objection does not apply to wide-ranging sciences, such as anatomy and physiology, which are not narrow, hedged-in areas, but which consist rather of broad and diversified domains composed of many contiguous fields, the varied nature of which is a perpetual refreshment. In practice the student of anatomy may divide his time between general anatomy, descriptive human anatomy, histology and embryology, all of which are now taught in the medical curriculum, and the student of physiology may pass from general and special physiology to physiological chemistry, thus resting the mind without interrupting the continuity of effort essential to instruction that must be both rich and frugal.

I would propose, then, that the first year in medical schools be divided equally between anatomy and physiology, the first four months being given to general anatomy, descriptive human anatomy, histology and embryology; the second four to physiology and physiological chemistry, studies which cannot be pursued without a knowledge of anatomy.

In accordance with the principles already outlined, the instruction in physiology should be divided into three parts. Part I, of five weeks' duration, should consist of a thorough drill in the physiology of nerve and muscle, the hours from 9 to 11 being devoted to experiments, the hour from 11 to 12 to study of *materia physiologica* (physiological preparations, graphic rec-

ords, etc.), and the time from 12 to 12:45 to a conference or seminary, which should be part lecture, part recitation. In the conference the bearing of the experimental work just done should be developed by systematic progressive questioning accompanied by running comments, to clear up any possible fog. A brief account of other experiments which add to the truth established by those which the student has done for himself, but which are too complex or too protracted to lie within the student's powers, should be brought in here.

Part II, of seven weeks' duration, should comprise carefully-arranged fundamental experiments giving in turn the elements of each field in physiology except that of nerve and muscle, which has just been studied. As before, the whole class works from 9 to 11 upon experiments, from 11 to 12 studies all possible means of illustrating the subject of the day, and from 12 to 12:45 attends the conference or seminary. In the forty-two days covering this part of the course instructors who find the mixture of lecture and Socratic method unsympathetic may abandon their questioning and fill the time with their own remarks; even such instruction would be far more fruitful than the present lectures, for the student would have had experience in anatomy and would be well grounded in experimental physiology, through his work on nerve and muscle, before the talk began; but the seminary is much more effective than the lecture.

In Part III, covering the remaining four weeks of the term, the instruction is divided into special courses on the physiology of the eye, ear, larynx, digestion, the spinal cord, the innervation of the heart, etc. Each course should consist of experimental work from 9 to 11, the study of preparations and other aids from 11 to 12, and a conference from 12 to 12:45. Each course should be long enough to include all the practicable experiments that should find a

place in a systematic, thorough study of the subject. The number of such experiments, and hence the length of the special courses, will naturally be very different in the various instances; thus experimental physiology of the eye will occupy more time than the physiology of the larynx. As many courses should be given at one time as there are instructors in the department. The student may elect the subjects that most interest him, but must choose a sufficient number to occupy him during the entire four weeks of instruction.

The afternoons of the days on which physiology is taught are devoted to physiological chemistry.

WM. T. PORTER.

HARVARD MEDICAL SCHOOL.

PSYCHOLOGY.

THE invitation to talk about the methods of teaching psychology was to me in one way very welcome. All the year long I have done nothing with fuller conviction than to tell the psychologists that they ought not to meddle with methods of teaching, as they can hardly offer any aid. But there is one exception, and here I have at last a welcome chance to make the necessary appendix to my year's sermon; the psychologists ought not to trouble themselves with the methods of teaching which the other men apply, but they ought, in the highest degree, look out for the methods which they use themselves, as there is perhaps no science in which bad methods are so confusing and dangerous.

But the invitation came also as an embarrassment. The methods of psychology, on account of the many changes in recent years, have so far not had the time to crystallize; they have not reached the stage of an objective form about which the psychologists themselves agree, and it is a hopeless task to seek there anything which is more than a reflex of personal experiences. I

felt this difficulty strongly and cannot offer, therefore, anything but an expression of my subjective convictions, which can claim in their favor nothing but the fact that they are based on observations in a university where the rather uncritical rush towards psychology has reached unexpected proportions.

The time is too short to demonstrate here, what even every outsider ought to know, that a scientific psychology is to-day in first line experimental psychology and that collections of instruments are thus the necessary, full laboratories the desirable background of teaching psychology. The audience, on the other hand, is here too various to allow a description of special important pieces of apparatus. I want, therefore, to emphasize merely questions of principle.

Such a question of principle it is to ask which place this experimental psychology ought to have in the lecture courses of the university. To say the experimental work ought to be the whole is absurd; that is possible for physics or physiology, but it is impossible for psychology. The physical sciences start with fundamental conceptions and presuppositions which are acknowledged without difficulty, while in psychology just the basal conceptions like consciousness, psychical causality, psychical elements, psychophysical parallelism are full of difficulties and certainly not open to experimental treatment. The usual way now is that the elementary treatment of mental life deals with this general theoretical book-psychology, while the more advanced lecture courses go forward to an exact experimental study of the special facts.

This seems to me a methodological blunder; the order ought to be just the opposite. I think, firstly, that the treatment of the theoretical questions in psychology is of no value whatever if it is given in an elementary way; every problem leads here to epistemological discussions which go far

beyond a sophomoric mind, and which are not simplified by avoiding the difficulties, but trivialized and falsified. Theoretical psychology is an advanced course for seniors and graduates. On the other hand, I think that experimental psychology can never be the object of a really advanced treatment in a lecture course. In physics or physiology the lecturer can reach the most advanced points because he can follow up the most difficult problems under scientific discussion with his experiments; not so in psychology. We must not forget that a psychological experiment is nothing but self-observation under artificial conditions. The lecture room cannot produce the conditions for any careful self-observation of every student beyond the most elementary questions. We can produce tone-sensations or color-sensations, or associations and space judgments, in a rough way for the whole class. If we try more we can do two things. Either we make demonstrations on one subject—for instance, reactions; then the whole class may see the person on whom the experiment is made, but the one person is really the only one who goes through the experience of the experiment; it is an illusion to think that the others get the advantage of the experiment too because they are in the same room. Or we choose experiments which every one can make individually at the same time—for instance, touch sensations; but it is clear that here only the most elementary problems are in question. Thus, wherever we come to a more complicated experimental question, the possibilities of the lecture room are at an end, and we have either to talk about experiments without making them—certainly a very bad scheme—or we have to shift them over to the laboratory courses, the only correct way. No other experimental science can come into this troublesome situation, because no other deals with self-observation, but we psychologists ought to confess that the experimental

work of the lecture room cannot go beyond the first elements of psychology, and is of a simplicity that every high school boy can understand. We must give up the pose that our psychological work becomes difficult on the introduction of a chronoscope and a kymograph and a color wheel. It is logically endlessly simpler than even the slightest serious discussion of theoretical psychology.

Of course, I am speaking of experimental psychology, which must not be confused with physiological psychology. The latter, in its narrower sense dealing with mind and brain, is either a theoretical discussion of the psycho physical parallelism, and as such fully dependent upon philosophical arguments and independent of empirical observations, or it is a study of the special localizations and functions of the brain parts. The first belongs to advanced theoretical psychology; the second does not belong to a student's course on psychology at all, but to physiology. It is mere coquetry if we decorate our real psychological courses with physiological bric-a-brac.

My method of teaching psychology in Harvard is as follows: I give a large elementary course in psychology which hardly mentions the brain, but which is from the beginning to the end an experimental course, and it is our special aim to construct instruments on a large scale, allowing every student in the audience to go through the self-observational experience of the simple experiments. Theoretical problems are there not discussed, but only touched. Those who have passed this elementary course have now no opportunity to cover the same experimental ground once more in advanced lecture courses, hearing three decimals where at first only one was given. No, they have two alternatives before them. They either enter the laboratory or they go on with lectures called 'advanced psychology,' hearing there hardly a single word about experiments,

and certainly never seeing an instrument in the lecture room. The advanced course is a theoretical discussion of the fundamental conceptions in psychology. The course is very difficult, but the fact that about one hundred advanced students take the course this year shows sufficiently how earnestly they feel the need, in our time—in which a thoughtless playing with psychology has become the fad of society—of discussing the principles of that science from a higher standpoint, and not only as a superficial introduction into experimental psychology.

Those who are interested in the details of the experimental work and want to follow it beyond the first elements which the lectures offered enter the training course in the laboratory, performing a prescribed set of individual experiments, working in groups of two. The question how far this training course ought to lead offers again methodological difficulties. We tried different schemes. My assistants gave last year two courses, the first training merely in well-known experiments, the second training in the scholarly attitude of the psychological investigator by carrying out some small investigations from which no gain for science was expected. This year we have dropped the second course and welcome every one, already after a-half year's elementary training course, to the regular original research work of the laboratory, in which, of course, everything is adapted to the effort to work towards the progress of science. We have come to this shorter circuit because with regard to the pedagogical value of original research work psychology has again quite an exceptional position; the self-observation factor, which stands in the way of the experimental work in the lecture room, becomes the greatest advantage for the psychological education in the research work. In physics or physiology you take the part of the in-

vestigator or you are outside; in psychology you can take a different part—you may be the investigator or the self-observing subject. And this subject part is, as every experiment is self-observation, in no way a less important and less scientific factor of the research, and yet it is still free from the administrative responsibilities of the investigator who carries on the experiment. To work for a time as subject in different investigations—every student of my laboratory takes part in at least three different investigations of different fields—is thus the very best bridge between the simple training course and the work which points towards publication and the Ph. D. My advice is thus to open the doors of the research laboratory rather earlier than the other exact sciences would wish to do; to work under constant supervision some time as subject seems to me even a better preparation than any special training course. The psychological seminary finally has to accompany this highest stage by advanced debates and papers; this work, in Professor James' hand, alternates in Harvard between more general questions and problems of abnormal psychology. The only defect which I must regret in this scheme is that we have so far no specialists for animal, child and social psychology. Child psychology finds a refuge in the department of pedagogy, social psychology in the department of sociology. They find in many universities to-day a very large amount of good will in both departments, but—and that is the last methodological principle which I wish to lay down—good will alone is also for psychological studies not always sufficient.

HUGO MÜNSTERBERG.

HARVARD UNIVERSITY.

ANTHROPOLOGY.

ANTHROPOLOGY is one of the subjects that have been added to the university curricu-

lum quite recently. For this reason I will devote my remarks to a consideration of the field that anthropological instruction is intended to cover and of its relations to allied sciences rather than to a discussion of methods of instruction.

According to purely theoretical definitions, anthropology is the science of man and might be understood to cover a vast range of subjects. The physical as well as the mental characters of man may be considered in a certain way as the proper field of anthropology. But sciences do not grow up according to definitions. They are the result of historical development. The subject-matter of anthropology has been accumulated principally by travellers who have made us acquainted with the people inhabiting distant countries. Another part of the subject-matter of anthropology is due to the investigation of prehistoric remains found in civilized countries. Only after certain methods had developed which were based largely on the information thus collected was the white race made the subject of investigation.

For this reason the aim of anthropology has been largely to explain the phenomena observed among tribes of foreign culture. These phenomena are naturally divided into three groups: (1) the physical appearance of man; (2) the language of man, and (3) the customs and beliefs of man. In this manner three branches of anthropology have developed: (1) somatology, or physical anthropology; (2) linguistics, and (3) ethnology. Up to this time anthropological investigation has dealt almost exclusively with subjects that may be classed under these three headings. These subjects are not taken up by any other branch of science, and in developing them anthropology fills a vacant place in the system of sciences.

The treatment of these three subjects requires close cooperation between anthro-

pology and a number of sciences. The investigation of the physical characteristics of man has also been taken up by anatomists, but the point of view of the anatomist and that of the anthropologist are quite different. While the former is primarily interested in the occurrence of certain modifications of the human form and in their genetic interpretation, the anthropologist is interested in the geographical distribution of varieties of form, in the variability of the human species in different areas and in their interpretation. The thorough study of physical anthropology, or somatology, requires the combined training of the anatomist and of the anthropologist.

In the study of linguistics the anthropologist deals with a subject that has been partially taken up by the student of special linguistic stocks. The study of the structure of the Aryan languages, of the Semitic languages and of the Mongol languages has been carried on with great success by philologists; but the anthropological problem is a wider one—it deals with the general question of human language.

In the study of ethnology the field of investigation of the anthropologist adjoins that of the field of research of the psychologist and of the sociologist. The development of a truly empirical psychology makes it necessary to draw largely upon material furnished by anthropological studies. On the other hand, sociologists have found that the analysis of the culture of civilized society cannot be carried out successfully without a comparative study of primitive society, which is the subject-matter of anthropological research.

The method of anthropology is an inductive method, and the science must be placed side by side with the other inductive sciences. Our conclusions are based on comparisons between the forms of development of the human body, of human lan-

guage, of human activities, and must be as truly inductive as those of any other science. By including psychology and anthropology in the present discussion on the methods of teaching science, we have given expression to the conviction that the method of investigation of mental phenomena must be no less an inductive method than that of physical phenomena.

The teaching of anthropology may be made to supplement in many ways the teaching of allied subjects, and I will briefly outline its functions in the university curriculum.

Physical anthropology has come to be primarily a study of the varieties of man. The differences between different types of man, defined either geographically or socially, are slight—so slight, indeed, that the biologist, until quite recent times, would have disregarded them entirely. Slight differences in type have been of importance to the student of anthropology at an earlier time than to the student of zoology, because we are more deeply interested in the slight differences that occur in our own species than among animals. This has led to the result that in anthropology sooner than in zoology the insufficiency of description was felt. Anthropology was the first of the biological sciences to substitute measurement for description and the exact number for the vague word. The method of measuring variable phenomena—in the case of anthropology, of the variations composing a type—had to be developed. It is only natural that in the course of this development mistakes were committed which had to be rectified, and that the sound method of metric description developed slowly. It would seem that at present we have reached the stage where the methods of metric description may be clearly recognized, and we may, therefore, expect confidently a rapid and wholesome development of physical anthropology. A glance at

recent biological literature shows very clearly that descriptive zoology and descriptive botany are passing at present to the substitution of metric description for verbal description that took place in anthropology some time ago. The study of anthropological methods may prevent biologists from repeating the same errors that were committed in the early days of anthropology. Anthropological subjects will, for a long time to come, remain the most available material for metrical studies of variations in the higher forms of life, because the material can be obtained in greater numbers and with greater ease than in studies of most of the higher animal forms. The metric method, which is at present principally an anthropological method, will, in a very short time, become of great importance to the student of biology, who ought, for this reason, to profit by the experiences of the anthropologist.

The fuller development of physical anthropology will lead to a study of the physiology and experimental psychology of the races of man. But in these lines of work we have hardly made a beginning. The relation of these inquiries to physiology and to psychology will be the same as that of physical anthropology to anatomy.

I may be allowed to pass by briefly the relations of the linguistic method of anthropology to other sciences. You will recognize at once that this subject, as well as its methods, must have a stimulating effect upon the teaching of philology, because its conclusions are based upon the broad grounds of human language; not on the studies of a single family of languages. The science of linguistics is growing slowly on account of its intrinsic difficulties. These difficulties are based as well on the lack of satisfactory material as on the amount of labor involved in the acquisition of knowledge in its particular line of research. Work in this field is most urgently needed,

because the languages of primitive man are disappearing rapidly, thus depriving us of valuable material for comparative study.

Ethnology, the last division of anthropology, covers a vast field. Its main object may be briefly described as the discovery of the laws governing the activities of the human mind, and also the reconstruction of the history of human culture and civilization. The methods applied by ethnologists are twofold. The investigation of the history of the culture of definite areas is carried on by means of geographical and of archaeological methods. The methods are geographical in so far as the types inhabiting a country, their languages and their customs, are compared to those of neighboring tribes. They are archaeological in so far as they deal with the prehistoric remains found in the country in question. In this case we apply inductive methods for the solution of historical questions. The investigation of the laws governing the growth of human culture is carried out by means of comparative methods, and is based on the results of the historical analysis referred to before. These laws are largely of a psychological nature. Their great value for the study of the human mind lies in the fact that the forms of thought which are the subject of investigation have grown up entirely outside of the conditions which govern our own thoughts. They furnish, therefore, material for a truly comparative psychology. The results of the study of comparative linguistics form an important portion of this material, because the forms of thought find their clearest expressions in the forms of language.

It appears, from these brief statements of the scope and methods of anthropological research, that an acquaintance with the whole field is indispensable for the sociologist; that a knowledge of results and methods will be of advantage to the psychologist, and that the statistical method de-

veloped in physical anthropology will be very helpful to the student of biology. In a general way, a knowledge of the outlines of anthropology seems to be of educational value, particularly in so far as it broadens the historical views of the student, because it extends his view over cultures and civilizations that have grown up uninfluenced by our own. The advances made by our own race will appear to him in a truer light when he is able to compare them with the work done by other races, and if he understands how much our own civilization owes to the achievements of people who appear to be at present on a low level of culture. The methodological value of the teaching of anthropology lies in the fact that it shows the possibility of applying inductive methods to the study of social phenomena.

FRANZ BOAS.

BOTANY.

THERE are some phases of botanical teaching that do not belong in the present discussion. University teaching, where selected, well-trained, devoted students pursue original investigation under the criticism and advice of great specialists, is excluded, for there is here no question of methods, but only of men. It represents the ideal relation of teacher to student, the true ideal for all botanical teaching. We have in this country some, but far too little of it. Again, college work proper, consisting in advanced thorough courses upon the practicum plan and in the investigation spirit, hardly belongs here. Such work has been stimulated by university example to a high degree of excellence, and in botany much of it is being done to-day in our colleges, a fact with an important bearing upon our present subject, for thus are being trained the teachers of the near future who are to elevate the teaching of the schools. But in the teaching of systematic elementary courses in botany, where these are not

under the direct control of teachers educated thoroughly and in the modern spirit, that is, in the elementary courses in many of the smaller colleges and in most high schools, there are questions and problems enough. Just here lies the center of discussion, effort and advance in methods of botanical teaching at the present time. Below the high schools, in primary and grammar grades, where systematic courses in the sciences are wisely not attempted, but a foundation is laid for them in continuous and thorough courses of 'Nature Study,' there are problems, too, but of a simpler sort, whose solution will follow upon the solution of those of the high school. Just as university teaching has elevated college teaching, both through example and through training teachers for it, just as in the same manner it is college teaching to-day that is elevating high-school teaching, so in the future will good high-school teaching improve that of the lower grades.

In describing the quality of most elementary botanical teaching I would not call it bad, but simply insufficient. It is not true that it commonly teaches error, or is useless as training, but it is true that it is far behind and unrepresentative of the present state of the science. This backwardness is illustrated in many ways, of which I shall mention but two. First, it is, as a study, low in public opinion, good public opinion, which regards it as synonymous with the study of the names of flowers, and hence as a discipline peculiarly fitted to the minds of school girls, or as an appropriate hobby for elderly persons of leisure. Second, it has stood low in the estimation of many university and college authorities, as shown by their frequent neglect to provide for its proper teaching, while amply providing for the sister science zoology, and some of the leading universities have not considered it as of particular value as an element in training in biology. It must be confessed

that these opinions are in the main just. Botany, as taught, has been too much the study of the names of flowers, and it has had very little to contribute of value for biological training. The reason for this backwardness is plain enough and most instructive—it is the result of an almost exclusive cultivation of a single phase of the science, entailing an abortion of other phases and an inability of the whole to respond elastically to the science as it broadens. This one phase has been classification of the higher plants, a phase determined by the overpowering influence of Dr. Gray, who for two generations towered so far above all other leaders of botany in America as to set his work as the standard, both for investigators and teachers. Systematic work involves an extreme attention to terminology and a concentration upon the statical aspects of plant structure. In the hands of poorly trained or overworked teachers it has run much to the filling-out of blanks, collection of herbaria and memorizing of lists of terms, thus becoming educationally little better than a system of mnemonics, or the working-out of mechanical puzzles. This sort of thing is not necessarily bad, but it is woefully uneconomical, one-sided, and neglectful of those other phases of the science that are attractive, useful and illuminating as knowledge, and rich in breadth and sympathy as training.

But these conditions have recently begun to change, and to-day are improving with a rapidity not realized outside of a few centers. The movement is with the expanding science, especially towards the study of the plant alive and in action. Its best evidence is to be found in the most recent elementary text-books, of which a large number, of increasing excellence, have appeared in the past two or three years. A comparison of the works, but a few weeks old, of Barnes or of Atkinson, with the best works of five years ago will show how rapid,

how great and in what direction the change is. Chief of the several causes of the advance is this: University and college teachers, imbued with the newer and broader spirit, are taking an interest in the elementary teaching of their subject not only in their own colleges, but also in the schools. If we consider the elementary text-books of approved standing and widest use in this country that have appeared within the past three years, those by Spalding, Bergen, Strasburger, Vines, Setchell, Curtis, L. H. Bailey, Barnes and Atkinson, we find that with but one exception, they are by university or college teachers. It is, of course, but presumption for any college teacher to attempt to instruct a school teacher in methods of imparting knowledge to school children; but the college teacher, with his broader horizon, larger command of the sources of knowledge, and better facilities for experiment, can best set forth what the science has to offer to education, and the most useful proportioning and treatment of topics. The new school teacher can be trusted to take care of his own methods. This is the spirit of the newer books; they do not seek to impose any system upon teacher or student, but are storehouses of knowledge and advice to be drawn upon by all according to their needs.

We turn next to a summary of advances actually being made in elementary botanical teaching, and of tendencies likely to be of importance in the near future. I need hardly speak of the continuous spread of laboratory and decline of rote instruction; happily this is now a matter of course. Aside from this, the first and greatest of current advances is the shifting of the point of view from the static to the dynamic side of the plant, entailing a great increase of attention to physiology and ecology. We are ceasing to look upon the plant as, first of all, a *structure* to whose parts certain functions attach, and are beginning to see it as a living thing

whose functions determine its structure, a working, struggling organism, plastic, though with an hereditary stiffness, to outside influences, not striving to realize some ideal plan, but simply to fit itself to the conditions that exist. Thus the leaf, from one point of view a structure of such a shape, size, venation, cellular composition, etc., carrying on the work of photosynthesis, is from another a mechanism so built as to expose a large amount of green tissue to light and to protect, support, supply and aerate it, and any given leaf is a resultant of the working of all these factors upon it, and as any one of them varies with the external influences so does the leaf vary. Now the clue to this view of the leaf lies in the necessity for light in the formation of starch, the food and sole source of energy of the plant, and this can be appreciated by a student only after experiment upon the relation of light to starch formation, experiment that happily is very easy and everywhere practicable. Thus approached, leaf-structure becomes luminous. In the same way it is absorption of liquids by osmosis that explains the root, and the resultant between the physical requirements of this osmosis and the varying external conditions under which roots are forced to grow, explains why a given root is the form, size and texture it is. Again, it is observation of modes of locomotion of pollen in effecting cross-fertilization, and secondary conditions connected therewith that explain the flower, and so on. Experience is showing that the only road to an objective understanding of anatomy and morphology lies through physiology and ecology. And this conception of the plant, as a living, working, struggling, plastic being is not only the truest, the most objective conception of it, but is, as well, the one that excites the greatest human sympathy and interest, and, therefore, is in itself the best 'method' the science has to offer.

It is sometimes objected that practical difficulties in thus teaching the science are too great to be overcome, for teachers are untrained, experiment is difficult and appliances are expensive. All this is in great measure true, but rapidly coming to be less so, and no one expects, nor is it desirable, that changes should come too rapidly. Many colleges are now training teachers in this knowledge and spirit, and simpler, less expensive and more logically conclusive experiments for demonstrating the fundamental principles of physiology are being invented. There is, however, one difficulty which must be admitted to be very real, namely, the present unorganized state of ecology. At present this division of the science is little better than a series of huge guesses; very little really conclusive work has been done in it, and no distinct methods of ecological experiment nor principles of ecological evidence have been formulated. Just here lies one of the most attractive fields open to botanists to-day, one whose returns will be of priceless value to botanical teaching.

A second advance is towards a more natural morphology. Next after classification the phase of botany most taught in elementary courses is morphology. But morphology as taught in our schools is dominated by a rigid formalism based on the idealistic system introduced into botany by Goethe, a system easy to teach and one that appeals to a certain stage of culture in both race and individual, but one objectively untrue, and one that, if allowed to dominate and direct morphological conceptions, is actually pernicious and sterilizing. It is only through an approach to structure from its statical or systematic side that one can be satisfied with the conception of plant morphology which views the higher plant as a combination of elements so immutable as to retain their nature through the most extreme changes and combinations,

even to the point of being present when invisible, that can find carpel and calyx in all inferior ovaries, can homologize the parts of a stamen with the parts of a green leaf, or ovules with something on the leafy shoot. From this formalism the newer books have broken away; their morphology conforms to the observed facts of plant development, which show adaptation not to a plan, but to conditions as they have existed.

Among minor advances may be mentioned a wider use of the inductive investigating spirit showing itself in the growing custom of placing new matter before the student in the form of problems so arranged that their solution comes just within the scope of his own powers. Another is a greater flexibility in laboratory methods. The day of published laboratory guides to be put into the hands of students is, I believe, passing; they will be replaced by outlines made by the teacher for each exercise to fit his particular mode of instruction and the material in hand. There is greater nicety and exactness, too, in the laboratory work; the 'rough sketch' is less heard of, and drawings whatever else they may be, must be diagrammatically accurate. Another is a better proportioning of laboratory and text-book work. There is a reaction from the tendency to make laboratory work everything and to scorn the text-book, and the latter, for supplementary reading after the laboratory work, is again in favor, and it is for this purpose the newer and better books are written. All of these advances and tendencies are most healthful and in the line of real advance.

I shall close this subject by pointing out three marked tendencies, not of botany alone, but of education in general, which, in my opinion, are most rich in promise for the advancement of botanical teaching, and which, therefore, all botanists should unite to promote. The first is the tendency to pay less attention to methods and more to

men; to obtain better material for the making of teachers; to educate them thoroughly in the spirit and matter of some one subject or limited group of subjects, and to leave them free to develop their own methods, judging them only by their results. This is what the universities have done with such signal success, what the colleges are now doing and what the schools must do if they are to advance. It is not methods that teach, but men and women. The second is toward the establishment of thorough and continuous courses in Nature Study through all grades from the kindergarten to the high school. There are two reasons for this from our present point of view. Thus only can students acquire a knowledge of the more obvious facts and phenomena of Animal and Plant life, Physical Geography, Physics and Chemistry so valuable as a basis for the systematic study of some one of the sciences in the high school. But, far more important than this is the use of Nature Study to preserve the natural inductive facilities of children unimpaired through school life, not to speak of improving these faculties through training. No fact about our later and better courses of elementary botanical study is more striking than the unanimity with which they begin with exercises adapted to train observation, comparison, etc.—in a word, induction. Now, these are powers that children possess naturally, the most universal of human faculties, those by which new knowledge is won; those by which self-made men succeed; those which surely above everything education ought to cherish and develop. But, as a matter of fact, these faculties somewhere between the primary and high school are so effectually throttled out of nine-tenths of our students that the first need of the high-school or college teacher is to redevelop them. This suppression is, of course, the result of excessive text-book and deductive work, which always tends to make students

distrustful of their own powers and leads them to regard as the only real sources of knowledge the thoughts of others properly recorded in printed books. Thorough and properly taught Nature Study is, in my opinion, the first need in all education to-day.

Third of the tendencies I have mentioned is this: The movement among the colleges to require, or at least accept, some one thoroughly-taught science for entrance, amongst which botany is always included. This will compel preparatory schools to improve their teaching, for the science offered must be enough in quantity and quality to allow students to omit the elementary course in the college and enter upon second courses. Moreover, this movement will allow college teachers to exert more influence than ever upon school teaching, for, controlling admission, they can state which topics are to be studied and what general methods are to be followed. A great part of the value to botanical teaching of this movement will, however, be lost, unless, in the very near future, the colleges, through their proper representatives, agree upon approximately-equivalent requirements, so that the preparatory schools may not be distracted and weakened by widely-differing demands.

Though botanists are thus eagerly striving to promote the interests of their science, it is not their desire unduly to magnify its importance, but only to give it its proper place in education and among the sciences. Their aim, I believe, may be thus expressed: Let education advance; let science advance; let botany advance.

W. F. GANONG.

SMITH COLLEGE, NORTHAMPTON, MASS.

ELEVENTH ANNUAL MEETING OF THE GEOLOGICAL SOCIETY OF AMERICA, DECEMBER 28TH, 29TH AND 30TH, NEW YORK.

I.

THE Geological Society of America completed the first year of its second decade with

the eleventh annual meeting at Columbia University, December 28th. Just nine years had elapsed since its last session in New York, which was held at the American Museum of Natural History. The Society assembled this year at 10 a. m., on Wednesday, the 28th, in the large lecture room of Schermerhorn Hall; Professor J. J. Stevenson, the retiring President, in the chair. President Low was introduced and in a few happily chosen remarks welcomed the Society to Columbia. After the usual routine business, President Stevenson read a memorial of the late Professor James Hall, so long State Geologist of New York and the first President of the Society. At the conclusion of the memorial Professor Stevenson delivered his presidential address upon the subject 'Our Society.' He sketched the rise and development of geological organizations in North America and discussed the important influence that they have exercised in the material progress of the country. The address appeared in full in the last number of SCIENCE.

The reading of papers was at once begun, as a list of fifty titles had accumulated.

The Archæan-Potsdam Contact in the Vicinity of Manitou, Colorado. W. O. CROSBY, Boston, Mass.

THE speaker described the remarkably plane character of the contact of the Archæan granite and Potsdam sandstone, which is in striking contrast with the existing topography of the granite even in coastal regions. He distinguished and described in detail, with numerous illustrations, the original and secondary irregularities, the latter including a few flexures and numerous small faults which throw important light upon the origin of the sandstone dikes of the Manitou district. The original irregularities of the contact are all small, and, as a rule, are evidently related to the existence in the Archæan granite of

a coarse concentric or spheroidal structure. The plane type of erosion-unconformity, although probably of rather widespread and common occurrence, appears to have attracted less attention than it merits. It suggests interesting possibilities as regards the development of peneplain surfaces in early times and invites a renewed comparison of the relative efficiency in base-leveling of subaerial and marine agencies. These more theoretical aspects of the subject were embraced within the scope of the paper, and the general conclusion was that the Archæan land surface must have passed with extreme slowness beneath the waves of the Potsdam sea.

The paper was illustrated with maps and lantern slides and excited great interest, but did not arouse discussion.

Outline of the Geology of Hudson's Bay and Strait. ROBERT BELL, Ottawa, Canada.

THE author described the general nature of the depression of Hudson's Bay; the contrasted characters of the opposite shores; the Huronian areas on both sides; the Intermediate Formation; the Animikie and Nipigon series; the Trenton group in Hudson's Bay and Strait; the middle Silurian rocks on the east, west and north sides of the Bay and in Baffinland; the large Devonian area southwest of James Bay; the Devonian rocks on Southampton Island; and the geology of the islands in the Bay. He gave a general geological description of Hudson's Strait and of the rocks of its north shore, or southern Baffinland. He also took up the Laurentian and older Cambrian strata of the Ungava district. Under the head of the economic minerals of the regions described, some details of the rich iron-ore deposits, involving carbonates, hematites and magnetites, were presented. In connection with the glacial geology of Hudson's Bay and Strait he sought to show the source of the ice that had yielded the

scratches and its direction of movement. The Quaternary deposits and the question as to the rate of elevation of the land received somewhat extended discussion. The author believes in the recognizable elevation within the historic period and briefly adduced the phenomena on which he based his conclusion.

In discussion B. K. Emerson stated that he was somewhat familiar with the rocks of the region from the collections of the Hall and Kane expeditions which are deposited at Amherst, and from others gathered years ago by English officers. In the latter were fossils of the Utica epoch. J. B. Tyrrell opposed the idea of the recent rise in the west shore of Hudson's Bay, basing his argument upon an old map of the region about Fort Churchill which showed relations like the present ones. David White inquired about the presence of lower Silurian rocks about Frobisher's Bay, and mentioned fossils of the Trenton period which had been identified by Schuchert. H. S. Williams asked if no strata above the Devonian were known. In reply, Dr. Bell again upheld the view that the land was rising and mentioned many arguments in support of it. The Trenton fossils, he said, had come from the northwest in the drift, and that no Carboniferous or later rocks, except Pleistocene, were known.

The Society then adjourned for lunch, and at the afternoon session begun at once the reading and discussion of papers.

The Faunas of the Upper Ordovician in the Lake Champlain Valley. THEODORE G. WHITE, New York City.

THE results of a detailed study of the consecutive faunas contained in each stratum at numerous localities throughout the length of the valley were presented after a preliminary description of the general geology. A complete section is afforded from the base of the Black River formation through

the Trenton and terminating in the Utica. Species hitherto reported only from Canadian localities are found associated with those characteristic of the Trenton Falls type-province, showing the Champlain connection with Ordovician seas. Several zones characterized by restricted species are located, and also 'Conglomeratic zones.' The fauna is very abundant and supplies a basis of comparison for similar detailed study from other provinces. The occurrence of the Hudson River and Oneida groups in the region is questioned.

In discussion H. M. Seely spoke of the attractiveness of the region and of its interesting problems and of the need of close paleontological study of the faunas. H. P. Cushing spoke in the same strain, and H. M. Ami remarked the close relationships of the faunas with those of Canada. C. S. Prosser remarked the resemblances and the contrasts with those of the Mohawk Valley.

The Newark System in New York and New Jersey. HENRY B. KÜMMEL, Chicago, Ill.

THE paper presented a general summary of the petrology, stratigraphy and conditions of origin of the Newark rocks in New York and New Jersey. The rocks form a northwestward dipping monocline, interrupted by gentle folds and many faults, two of which have a throw of several thousand feet. The lithological character varies greatly, so that sub-divisions established in one area do not hold for the entire field, and yet sub-divisions based on lithological characteristics are the only ones possible. The author classified them into the Stockton, the Lockatong and the Brunswick formations, together with the traps. Both extrusive and intrusive trap sheets occur and their relations to the sedimentary beds are instructive. The question of thickness is complicated by the faulting. Estimates vary from 12,000 to 15,000 feet. The strata were probably accumulated under estuarine con-

ditions in shallow water. The surrounding land areas seem to have been reduced nearly to base-level and deeply covered with residuary materials immediately preceding the deposition of these beds, but during their deposition subsidence of the estuary and elevation of the surrounding areas was in progress. The paper was illustrated by lantern slides.

In discussion B. K. Emerson brought out many points of resemblance with the Jura-trias strata of the Connecticut Valley and N. S. Shaler compared them with those of the Richmond, Va., basin. He argued against their marine origin and in favor of lakes either salt or fresh. A. Heilprin spoke of the fishes which were considered as probably marine by Cope, but N. S. Shaler stated in reply that near Richmond the fish were found in association with vegetable remains. No definite view was reached on this point, although B. K. Emerson remarked that the casts of salt crystals were often seen in the shales in New England. I. C. Russell raised the point of the former extension of the Newark strata of New Jersey to the eastward, but the author had no light to throw on the question. J. E. Wolff and J. F. Kemp discussed the distribution of the boulders from the trap and its contacts over New York City and Long Island.

Discovery of Fossil Fish in the Jurassic of the Black Hills. N. H. DARTON, Washington, D. C.

THE speaker exhibited several specimens of the recently discovered fossil fish and described their occurrence in the Jurassic beds on the confines of the Black Hills. The fish are now being investigated by specialists. The paper was immediately followed by the next one.

Mesozoic Stratigraphy in the Southeastern Black Hills. N. H. DARTON, Washington, D. C.

THE author exhibited a diagram of details

of stratigraphy determined in 1898. The investigation resulted in the discovery of marine Jurassic in the southern Black Hills, and of an horizon of large vertebrates in the lower Cretaceous. The paper was beautifully illustrated by lantern slides, and on its conclusion the Society adjourned until the following day.

In the evening the Fellows attended the reception, which was most hospitably extended to the visiting scientific societies by the authorities of the American Museum, and listened with great interest to the addresses of Mr. Morris K. Jesup and Professor Henry F. Osborn. They also attended the reception given by Professor Osborn, at his residence, at the close of the lecture.

On reassembling Thursday morning the reading of papers was at once resumed, the following two contributions being presented together :

Relations of Tertiary Formations in the Western Nebraska Regions. N. H. DARTON, Washington, D. C.

THIS paper presented the results of several seasons' investigations of the White River and the Loup Fork formations, extending from the South Platte River into the Bad Lands of South Dakota.

Shorelines of Tertiary Lakes on the Slopes of the Black Hills. N. H. DARTON, Washington, D. C.

DURING the season of 1898 the author discovered extensive and beautiful shorelines and deposits of the Tertiary lakes far up the slopes of the Black Hills. They throw interesting light on certain stages of physiographic development of the Black Hills and the origin and condition of deposition of some of the White River sediments.

No discussion resulted.

General Geology of the Cascade Mountains in Northern Washington. ISRAEL C. RUSSELL, Ann Arbor, Mich.

THE region under discussion covers an area from the Northern Pacific Railroad to the Canadian boundary, sixty miles east and west by one hundred and twenty north and south. The following topics were taken up: **TERRANES**.—A. *Eruptive*, general absence of basalt, the schists, granites and gneisses, greenstones, andesite of Glacier Peak, volcanic tuff and dust, acid and basic dikes, the source of the Columbia lava. B. *Sedimentary, Pretertiary, i. e.*, Carboniferous and Triassic strata, including the Similkameen system and the Ventura system. C. *Tertiary* strata, including Snoqualame slate, Winthrop sandstone, Camus sandstone, Swank sandstone, Roslyn sandstone, Ellensburg sandstone. Abundance of fossil leaves. D. *Pleistocene* strata, moraines and valley gravels.

STRUCTURAL GEOLOGY.—Domes, including the Cascade dome, the Wenatchee dome. Folds and faults. *Physiography*: The Cascade peneplain, the Cascade plateau, dissection of the Cascade plateau. Mature topography. Low-grade valleys.

ANCIENT GLACIERS.—On the east side of the Cascades: Yakima glacier, Wenatchee mountain glacier, Icicle glacier, Wenatchee, Chelan, Methow, Okanogan glaciers. On the west side of the Cascades: Sauk glacier, Skagit glacier, confluent ice sheet. Absence of northern drift. Gravel deposits.

TERRACES.—Great terraces of the Columbia, the Snake and Spokane, due to climatic changes. No evidence of recent submergence; absence of white silt.

EXISTING GLACIERS of the Wenatchee mountains and the Cascades.

CLIMATE.—The rainy western slope with dense forests and the dryer eastern slope with open forests and grass.

ECONOMIC GEOLOGY.—Coal, gold, copper, iron, building stone, clays, etc.

In discussion Bailey Willis expressed doubts as to the divisibility of the Tertiary sandstones into so many distinct members,

believing that combination would be necessary. He also argued that the domes were due to cross-folding rather than to laccolithic uplift, as urged by Russell. S. F. Emmons suggested lava dams as the cause of the terraces rather than submergence or change of climate. G. M. Dawson said that the white silt was not to be expected in the region under discussion and favored submergence and glacial ice as the causes of the terraces. In reply I. C. Russell stated that the lava flows were older than the terraces, as the terrace gravels were present in cañons cut in the lava. He admitted that Willis's views regarding the sandstones and the uplifts might prove correct and that the causes of the terraces was obscure.

The Society then adjourned for lunch. On reassembling the subject-matter of W J McGee's paper was introduced by W. H. Holmes. Holmes described the discovery of bones and artefacts on the surface in the vicinity of the California gravels that had yielded buried skulls and implements, and detailed the stories of old residents regarding the large part that practical jokes played in the discovery of the remains. He illustrated the geology of the Table Mountain region by sections, and developed the general argument that the relics were those of Digger Indians, who are still in residence, or were within the period of the gold miners. He was followed by W J McGee before discussion opened.

Geology and Archaeology of the California Gold Belt. W J MCGEE, Washington, D. C.

IN continuing the paper of Holmes the speaker sketched the geological history of the Western Sierras, emphasizing the Tertiary age of the gravels, the ancient drainage; the inflow of tuffs and lavas; the subsequent erosion of the present steep river cañons to a depth of 2,000 feet. He stated that in this time the fauna and flora had

entirely changed, no species, and, so far as he knew, no genus lasting through to the present except that most variable of all genera, *Homo*, and the species most sensitive of all, to physical changes, *sapiens*. Not only this, but the relics were those of the men, the Digger Indians, living there today, and when not bones the objects were those connected with the acorn industry of the present tribes. From all these considerations a sweeping argument supporting the general improbability of the geological antiquity of the remains was adduced.

In discussion W. H. Brewer spoke of the circumstances under which the discovery of the Calaveras skull was made, he having been at the time on the California Geological Survey. He described its fossilized condition and its contained cemented gravels and stated his belief in its very considerable age even if not Tertiary. He also gave an interesting account of the great theological and ecclesiastical opposition to Professor Whitney that the announcement of the geological age of the skull aroused, amounting almost to persecution. The discovery came shortly after the publication of Darwin's views on the descent of man and in the midst of the excitement that these views aroused.

Major Powell recounted a number of his experiences with discovered relics and the tendency of collectors to palm off modern things as antiquities either in joke or as a fraud. He emphasized the need of depending absolutely on geologists for all reliable testimony as to authentic occurrences in sedimentary deposits. J. A. Holmes spoke in support of the Major's view and related the recently recorded discovery of implements in marl pits and Eocene limestone in North Carolina, the same being attested by affidavits of reputable citizens.

Geology of the Lake Region of Central America.

C. WILLARD HAYES, Washington, D. C.

THE speaker discussed the following topics, illustrating his remarks by a fine map. His data had been accumulated while in the service of the Nicaragua Canal Commission and especially from test borings: *Introduction*: general relations of the country under discussion. *Topography*: the coastal plain; the Chontales hills; the Tola hills; the Costa Rican volcanic range; the Nicaraguan volcanic range; the Jinotepe plateau; the lake basin; the Rivas plain. *Climate*: the eastern section of heavy rainfall and dense forests; the western of lighter rainfall and savannahs. *Rock formations*: Tertiary sediments including the older Brito formation and the later Machuca formation; Tertiary igneous rocks, dacites, andesites, basalts, volcanic breccias and conglomerates; recent sediments, alluvium; recent igneous rocks, trachytes, basalts, tuffs and pumice. *The Regolith*: the conditions favor rock decay; the great depth of weathering; red and blue residual clays; concerning weathering in igneous and sedimentary rocks. *Recent geologic history of the region*: early Tertiary deposition; Tertiary erosion; late Tertiary and post-Tertiary uplift and dissection of uplands; recent submergence and alluviation; recent volcanic activity; formation of lakes and shift of divide to westward. *Characteristics of San Juan Valley*: the upper flood-plain; the Castillo-Ochoa gorge; the lower flood-plain.

The paper aroused the liveliest interest from the great importance of the project of the international canal. J. E. Wolff asked about the nature of the rock decay and whether silica, the alkaline bases and iron were removed, leaving beauxite, or whether hydrated silicates resulted. Mr. Hayes replied that he thought the latter, but that no analyses had yet been made of his many samples. Inquiries were raised about the recency of the volcanic outbreaks and the nature of the lava. The reply was that the lava was basalt and the last outbreak about fifteen years ago.

An Unrecognized Process in Glacial Erosion.

WILLARD D. JOHNSON, Washington, D. C.

THE glacial topography of mountains was analyzed, and the more distinctive forms discriminated from those of aqueous erosion. The recognized process, that of scour, its action downward and forward with the glacial advance, was described. Glacial scour and aqueous erosion were regarded as alike incompetent to bring about the results and as a rule inimical to the production of known forms. An unrecognized process was set forth, that of sapping, whose action is horizontal and backward. The tendency of glacial scour is to produce sweeping curves and eventually a graded slope. The tendency of the sapping process is to produce benches and cliffs. Sapping is altogether dominant over scour. Under varying conditions, however, its developing forms become obsolescent; their modification, then, by rounding off of angles, puts them seemingly into the category of scour forms. An hypothesis was advanced as to the cause of glacial sapping. The ultimate effect is truncation at the lower level of glacial generation. A second analysis and a more appreciative classification of transition types terminated the paper.

Before discussion the next paper was read because it dealt with allied phenomena. The hour, however, being late, the discussion went over till the next day.

Geology of the Yosemite National Park.

H. W. TURNER, Washington, D. C.

By means of lantern slides the author illustrated the topography of the granite areas in the high Sierras and the Yosemite and other allied gorges. He developed the view that joints had chiefly caused the precipitous cliffs, and concentric shelling off, the domes. Minor forms were also explained. He opposed the view that faulting had caused the gorges.

Gold Mining in the Klondike District.

J. B. TYRRELL, Ottawa, Ont.

By means of a fine series of lantern slides the author illustrated the geographical situation and the geology of the Klondike gold-bearing gravels. The stream gravels are the usual type of placers, but the bench gravels are small lateral moraines left by glaciers. The gold has not been derived from any distance.

The Nashua Valley Glacial Lake.

W. O. CROSBY, Boston, Mass.

By means of lantern slides from photographs and from maps and profiles based on bore-holes made by the officials of the Boston department of municipal water supply, the speaker described the bed-rock surface, the overlying gravels on the Nashua River, and the characters of the old glacial lake of whose former existence they gave evidence.

On the conclusion of the paper, at 5:45 p. m., the Society adjourned until the following day. In the evening about one hundred Fellows, many with their wives, gathered at the Hotel Logerot for the annual dinner. Under the presiding oversight of Professor B. K. Emerson, the past grand master of all the toastmasters, another enjoyable gathering was added to the list of those previously held.

J. F. KEMP.

COLUMBIA UNIVERSITY.

(To be Concluded.)

SCIENTIFIC BOOKS.

Theory of Groups of Finite Order. By W. BURNSIDE, M.A., F.R.S., Professor of Mathematics at the Royal Naval College, Greenwich. Cambridge, The University Press. 1897. 8vo. Pp. xvi+388. Price, \$3.75.

If, assuming a single but elevated point of view, we describe mathematics as the science of formal law, then the theory of operations easily commands the field, for it is the quintessence of mathematical form, the comparative anatomy,

so to speak, of the mathematical sciences. Originally appearing under the special guise of the theory of substitutions and developed in this form by the labors of Galois, Cauchy, Serret and Jordan with reference chiefly to its application to the theory of equations, it has of more recent years overleaped at once its scientific and its national limitations and, receiving new impulse at the hands of Kronecker and Cayley, has been developed largely by Klein and Lie into one of the chief general instruments of mathematical research. In every branch of mathematics the point of view of the theory of operations is now predominant; it is employed in almost every form of mathematical investigation, and by the reaction the science is in turn constantly enriched. Conspicuous instances are Klein's theory of the modular equations and Lie's theory of differential equations.

The number of separate works devoted wholly or in part to the theory of operations is comparatively very small. Serret's *Algebra* held the field alone down to the appearance in 1870 of Jordan's classical *Traité*. Netto's *Theory of Substitutions*, published in 1882, was the first German book on the subject and represents, as regards its special subject, the German (Kronecker) standpoint down to that date. The American translation (1892) of Netto's book was the first separate work in English to touch the field; in fact, it was almost the first presentation of the subject in any form in English. In 1895-96 appeared the two volumes of Weber's *Algebra*, a work the value of which as a systematic and modern treatment of the various branches of algebraic science cannot be overstated. To this work, rich in other treasures, belongs the distinction of being the first treatise to present the theory of operations in general form independent of the particular content to which the operation might be applied. Closely following the work of Weber, comes now the second English book on the algebra of operations, Burnside's *Theory of Groups of Finite Order*. Professor Burnside's work is a doubly welcome contribution to the literature of the subject. It not only opens up to the English reader a great and hitherto almost foreign field, but it presents in a form often original and always valuable the most recent develop-

ments in that field, to which the author himself has, in fact, made no insignificant additions. Many portions of the subject, otherwise only to be gathered piecemeal from the journals, are here brought together for the first time in orderly sequence. Proofs have been recast and simplified or extended, and the book contains an abundance of those special details and examples, perhaps too familiar in English mathematical works, but very acceptable here in the midst of a highly abstract theory.

To the reader whose vocation or avocations have not lead him into this remote region of serene thought a short excursion among the groups may be instructive and more or less agreeable. Let him, then, first become familiar with the idea of the 'product' of two operations. This is simply the single operation which alone produces the same effect as the successive performance of the two given operations. If it be asked: "What sort of operations do you mean?" I reply with unction: "Any kind you please, and the more general the conception the better." Algebraic, geometric, physical, chemical, even metaphysical or 'socio-logical' operations, if nothing better offers, all are taken in one net. But to condescend from this lofty altitude, let us take for an example the rotations of a sphere about its diameters. Choosing any two of them, and applying them successively to the sphere, regarded as a rigid body, the resulting, or *resultant*, displacement of the sphere is equivalent to a third rotation about a proper diameter. This third rotation is, then, the *product* of the two given ones. The rotations of the sphere, taken all together as a system, serve also to exemplify the next important notion, that of a 'group.' When a system of operations is so constituted that the product of any two of them is itself an operation of the system, so that the system is a *closed* one with respect to the process of forming products, then if a couple of minor conditions are also satisfied, the system forms a group. And now the theory of operations in its present form concerns itself not with all kinds of operations, but with these groups. Examples of groups are not far to seek, after the idea is grasped. No science is exempt from them; in mathematics they simply tumble over each other. Transfor-

mations of coordinates in geometry form a group; so do the projections of a plane or of space; the motions of space as a rigid body form the Euclidean group of motions; the $n!$ permutations of n letters form a group; the eight permutations of x_1, x_2, x_3, x_4 which leave the function $x_1 x_2 + x_3 x_4$ unchanged in form, form a group; the multiplication table, the operations of the post office, the theory of the tides, psychological phenomena, all embody characteristic groups. A specially important class of groups, which may serve to close the list, is that of the linear transformations (which are formally identical with geometric projections and with various other operations). Thus the equation

$$z' = \frac{az + \beta}{\gamma z + \delta}$$

may be looked upon as defining an operation by which any number z is connected into a corresponding number z' . If we have two of these operations, and if, having applied the one to z , getting z' as a result, we apply the other to z' , getting z'' as a result, then an examination will show that z'' is itself a linear function of z , i. e., the product of two linear transformations is a linear transformation.

Prepare now for a step into the abstract. In expressing ourselves in terms of 'operations' we have been walking on the crutches of the concrete. But if we designate the operations of a group by A, B, C, \dots , their products AB, BC, \dots have a definite mode of formation, constituting an *algebra*, and we will now throw away the 'operations' and keep the symbols and their algebra. The symbols are now 'elements,' and if these elements form a group the product AB is identified by the algebra with some element C of the same group. Two other properties have to be added to make the definition of a group precise: (1) the algebra must be associative, i. e., $(AB)C = A(BC)$, and (2) if $AB = AC$ then $B = C$ and if $AB = CB$ then $A = C$. Algebras can, of course, be constructed which omit these conditions, but they are not algebras of groups.

The *order* of a group is the number of its elements. A group may be of finite or infinite order, e. g., all the rotations of a sphere about its diameter form an infinite group; those of

them which turn into itself a regular polyhedron inscribed in the sphere form a finite group. Infinite groups are only touched on in Burnside's book. Access to their theory is most readily had through Lie's works. Burnside's opening chapter on abstract groups (Chapter 2) is not so happily executed as Weber's treatment (Vol. II., Chapter 1), which is a masterpiece (Cf. also Frobenius's 'Ueber endliche Gruppen,' *Berliner Sitzungsberichte*, 1895, p. 163). Burnside retains the operations and makes use of their concrete qualities in discussing properties which are better treated in the pure abstract.

From the mere definition of a group it is possible to raise a considerable crop of properties without any artificial fertilizer. Add the ideas of isomorphism and transformation, and consider the groups whose elements are commutative (Chapter 3), and those whose orders are powers of single prime numbers (Chapter 4), and the wilderness fairly blooms. Even the non-specialist may rapidly make his way through the easy roads and add valuable ideas to his stock as he goes. He can hardly do better than to read this book, which gives a very clear and straightforward treatment of these general matters. But this is mere surface production. Underneath is gold, but only the Frobenius brand of dynamite will reach that. More than twenty-five years ago a solitary prospector, Sylow, found the lode and worked it with good results as far as he could follow it. Others have tried new leads, but none have accomplished anything remarkable until the work of Frobenius, who in the past ten years or so, and more particularly in his articles published in the *Berliner Sitzungsberichte* for 1895-6 has opened up a vast wealth of new relations, at the same time revising and enriching the earlier methods, nomenclature, and general point of view. Some of the most prominent of Frobenius's results are discussed in Chapter 6. Another line of ideas, which, however, dates back in its beginning as far as Galois, and has been improved especially by Hölder, the theory of composition of a group, is discussed in Chapter 7. The three following chapters are devoted to an extensive discussion of substitution groups, whose theory has also been considerably extended of recent years. The theory of isomor-

phism of a group with itself, also a very recent notion, is given a full chapter. The scene then shifts to the graphical representation of groups, exploited by Klein in his treatment of the automorphic functions, and treated separately by Dyck, whose methods are here employed. Cayley's color groups also receive attention. A chapter follows on the linear group, following Jordan's classical discussion. Finally, Sylow's theorem and its derivatives are applied to the determination of the composition of groups whose order are resolved into prime factors.

The book concludes with a useful trilingual table of equivalent technical terms and a still more useful Index. The publishers have done their full duty; the type is large and clear, and the paper gives a good impression. The text would have been improved by the introduction of descriptive section headings, and frequently the reader is not kept comfortably informed of what the author has in view, and must suspend judgment for a too lengthy interval.

The small public to which such a work appeals makes it unlikely that books on the theory of groups should ever become very numerous. It is fortunate, therefore, that in Professor Burnside's treatise we have a work of genuine and permanent value from which many a future student may draw wholesome inspiration.

F. N. COLE.

Elements of Sanitary Engineering. By MANSFIELD MERRIMAN. John Wiley & Sons. 1898.

The book opens with an interesting and, for a student, instructive series of historical notes. This is followed by a section dealing with 'classification of disease,' wherein may be found the novel proposition that 'disease is normal and health ideal—' a view that will call forth much opposition.

The illustrations distinguishing between contagion and infection are good, but the suggestion that goitre is probably due to the use of limestone water is hardly warranted; for, were it a fact, the hard waters of southern England should produce the disease abundantly.

An excellent and timely statement is given in the table on page 17, showing how much more serious is consumption than sundry other

diseases against which we take far greater pains to guard.

The relation of filth to disease is well put, and the illustrations are striking. The chapter on 'drinking water and disease' is in terse form, suitable for class-room work, but the remarks concerning the Hamburg cholera epidemic need to be supplemented by a map of the city, in order to grasp fully what may be learned from that instructive outbreak.

The book is evidently intended for use as a student's text-book, and excellent questions are inserted at frequent intervals, which require the student to make use of a reference library. This is a very valuable feature, and one but rarely found. There is, unfortunately, no index. M.

Bush Fruits: A Horticultural Monograph of Raspberries, Blackberries, Dewberries, Currants, Gooseberries and other Shrub-like Fruits. By FRED. W. CARD, Professor of Horticulture, Rhode Island College of Agriculture. The Macmillan Company. 1898. Pp. xii + 537. Price, \$1.50.

Under this concise and somewhat descriptive title another book is added to the list upon small fruits, from which, in this instance, are excluded the grapes, strawberries and cranberries.

The contents are divided into three parts, namely, (I.) General Considerations, (II.) The Brambles and (III.) The Groselles. The last name is adopted from the French, includes both the currants and gooseberries, and is a convenient term as a heading for a book division, but will scarcely be of much service elsewhere.

Under brambles, of course, the red raspberries, black raspberries, blackberries and dewberries are considered each with its separate chapter.

Part I. deals with the consideration of location, fertilizers, planting, tillage tools, pruning, propagation, thinning, spraying, picking, packing and marketing of fruit, with a few closing pages upon the methods of crossing and the results of such blending of the varieties and species.

Many of the above-mentioned points are again more specifically treated under the chap-

ters devoted to the separate groups of bush fruits, and the whole book is so planned that the practical grower may quickly reach replies to the questions in hand by means of a full index even to the varieties of each sort of fruit embraced by the work.

The more scientific portions of the volume are kept as far as possible by themselves, set in smaller type and include histories of the various sorts of fruits, their insect enemies and fungous diseases. This separation is a wise provision for the convenience of the grower, for whom the book is especially written and who is more interested in the art of producing a profitable crop than the underlying principles of botany upon which the art securely rests. For example, there are nearly fifty pages of descriptive text of species of *Ribes* set under the chapter title of 'The Botany of the Groselles,' and many of the species are figured. Such portions of the work as this are of much value to all who desire to advance American horticulture by introducing new species to cultivation or extending the range of hybridization.

In the more practical part it may be noted that special stress is placed upon the evaporation of the fruit, and several illustrations are given of the apparatus employed in this growing industry. In the preface, by the editor of 'The Rural Science Series,' of which the 'Bush Fruits' is the sixth volume, Professor Bailey states that 'the aim has been to treat general truths and principles rather than mere details of practice.'

The book is written by one who has both an experience with bush fruits and a knowledge of the best things that have been thought and said along the lines he has followed out to a successful issue in the volume in hand.

BYRON D. HALSTED.

The Lower Cretaceous Gryphæas of the Texas Region. By ROBERT THOMAS HILL and THOMAS WAYLAND VAUGHAN. Bulletin of the United States Geological Survey, No. 151. Washington, Government Printing Office. 1898. Pp. 66. Pl. xxxv.

The main object of the authors in publishing this brochure is to set aright the confusion that has long existed regarding the classification and

stratigraphic position of a series of fossil oysters commonly assigned to a single species, *Gryphæa pitcheri*, Morton. They occur in especial abundance in the Lower Cretaceous formations of Texas, and when properly classified are found to be of great value in determining the position of strata. From forms heretofore known as *G. pitcheri* at least eight species are here recognized (Table, pp. 45-46), viz., *G. vesicularis*, Lam., 1806; *G. newberryi*, Stanton, 1893; *G. mucronata*, Gabb, 1869; *G. washilaensis*, Hill, 1889; *G. navia*, Hall, 1856; *G. corrugata*, Say, 1823; *G. marcoui*, Hill and Vaughan, 1898; *G. wardi*, H & V, 1898. It is found, furthermore, that even Morton's species (so long considered the type) must be abandoned in favor of Say's *G. corrugata*.

The introduction, dealing historically with the controversy of many years' duration concerning *G. pitcheri* and the formations in which it occurs, is not without a moral, inasmuch as it plainly shows that an inadequate description, with a poor figure, may become a fruitful source of error, which, as in the case of the species under consideration, may be greatly augmented by the want of proper stratigraphical knowledge on the part of collectors.

An account of the fossil oysters of the Texas region and a classification of the Ostreidæ follows. The difficulties encountered by the authors are not underestimated: "In undertaking the study of the Ostreidæ one is soon confronted with the question: What constitutes species and genera in this group? The variation of species is much greater in the Ostreidæ than in other molluscan genera. No other group presents such unsatisfactory criteria for specific differentiation. These forms, judging from their stratigraphic occurrence as well as their habits, seem to adopt new variations of shape with every change in physical condition of habitat, as is illustrated in the variations of our living species. Changes similar to those occurring at the present time have occurred in the past, and no doubt many species have arisen by some of these local variations becoming fixed and persistent. Large suites of specimens often show that two species usually considered very distinct may grade into each other. The intergradations are of such a kind that frequently it can easily

be shown that the two species have been derived from a common ancestor; in other cases one species is evidently derived from another occurring stratigraphically below it."

Contrary to the prevailing opinion that fossil oysters, on account of their great variation, are of little value in the recognition of strata, our authors are led by their observations to conclude "that certain forms of the Ostreidæ possess very distinct specific characters, have definite geologic horizons, and are of the greatest value in stratigraphic work." They recognize the fact, also, that no scheme of classification can be entirely satisfactory until both fossil and recent oysters have been "the subject of thorough investigation from a phylogenetic and morphologic standpoint, according to the lines of research followed out by Hyatt in the cephalopods, Jackson in the pelecypods, Beecher and Schuchert in the brachiopods and Von Koch in the stony corals."

Sixty-one accepted species and varieties of fossil oysters are listed as occurring in the Texas Cretaceous, and twenty-three indefinite and abandoned species. Of the former forty-seven are tabulated as characteristic of definite horizons (p. 31).

Under the caption 'Historical Statement of the Discovery in the Texas Region of the Forms referred to *Gryphæa pitcheri*, Morton,' the confusion of various authors concerning this famous fossil is clearly presented and the sources of error pointed out. The following topics of more than ordinary interest are also discussed: 'Differentiation,' 'Geographic and Stratigraphic Distribution of the Lower Cretaceous *Gryphæas*,' 'Specific Classification and Evolution of the Lower Cretaceous *Gryphæas*,' and the bulletin closes with careful descriptions of six species, characteristic of the Lower Cretaceous, which the authors believe to merit recognition, supplemented by a brief statement of their relationship. The excellent and copious illustrations which accompany this paper deserve especial commendation. Of thirty-five plates, thirty, including copies of figures from Hall, Marcou and Roemer, are devoted to *Gryphæas*; of the remainder, one is a view of a living oyster bed, showing the profusion of molluscan growth, the others sections showing the strati-

graphic occurrence of the Texas Cretaceous Ostreidæ.

FREDERIC W. SIMONDS.

UNIVERSITY OF TEXAS.

BOOKS RECEIVED.

Calcul de généralisation. G. OLTEAMARE. Paris, Hermann. 1899. Pp. viii+191.

Report of the Commissioner of Education for the year 1896-97. Washington, Government Printing Office. 1898. Vol. II. Pp. 1137-2390.

The Human Body. H. NEWELL MARTIN. Fifth Edition, revised by GEORGE WELLS FITZ. New York, Henry Holt & Co. 1898. Pp. xiv+408.

Elements of Graphic Statics. PROFESSOR L. M. HOSKINS. New York and London, The Macmillan Company. 1899. Pp. viii+199, and eight plates. \$2.25.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *American Naturalist* for January opens with an article by Dr. Arthur Hollick discussing the relation between forestry and geology in New Jersey. Professor W. M. Wheeler gives a biographical sketch of the late George Baur, which is accompanied by a biographical sketch containing 144 titles. Articles follow by Miss Julia B. Platt, describing certain phenomena of geotaxis; by Professor Cockerell, on 'Vernal Phenomena in the Arid Regions,' and by Professor E. W. MacBride, reviewing Seitaro Goto's work on the development of *Asterias pallida*.

THE *American Geologist* for January opens its twenty-third volume with a notice of Edward Drinker Cope, by Miss Helen Dean King, with a portrait and a bibliography containing 815 titles. There follow articles by Dr. N. H. Winchell, on 'Thalite and Bolingite from the North Shore of Lake Superior,' and by Mr. Marsden Monson, on 'The Loss of Climatic Evolution.'

THE *Journal* of the Boston Society of the Medical Sciences for December, 1898, contains an abstract of an interesting paper by Dr. Morton Prince entitled 'An Experimental Study of Visions,' also an important paper by Dr. Franklin W. White upon 'the Germicidal Properties of Blood Serum.' Among the conclusions reached are these: Human blood serum differs greatly in its germicidal action

upon various bacteria ; in fatal diseases it sometimes loses part of its germicidal power for the colon bacillus shortly before death, but more frequently retains this power for several hours after death ; human blood serum does not lose its germicidal power for typhoid and colon bacilli, even in the late stages of chronic wasting disease.

THE *Philadelphia Medical Journal*, which during its first year has secured a high position among medical journals, will hereafter publish a monthly supplement of 60 pages containing original articles.

SOCIETIES AND ACADEMIES.

NATIONAL GEOGRAPHIC SOCIETY, JANUARY
6, 1899.

Abstract.

'THE Work of Glaciers in High Mountains :'
By Willard D. Johnson. The greater number of the imposing forms in the summit regions of nearly all high mountains are of unknown origin. They are, however, strictly confined to tracts which either have in the recent past been glaciated or are glaciated now. Presumably, therefore, they are of glacial origin. But the difficulty is that, according to the known laws of glacial erosion, they are unintelligible.

The recognized process in glacial erosion is scour. This process, like aqueous corrosion, must always tend—in uniformly resistant and unfractured material—to produce graded slopes. But in glaciated summit regions, especially in granite and in tracts of that rock which answer most nearly to ideal conditions of uniform hardness, the topography is essentially that of flat valley floors and of upright cliffs, transverse as well as longitudinal to the direction of flow. In sound rock both glacial scour and aqueous corrosion will be not only incompetent but inimical to the production of such forms.

An unrecognized process appears to be that of sapping. The transverse, and therefore buried, cliffs in the glacier's pathway, as well as the amphitheatral cliff at its head, are cliffs of recession. The action of scour is downward and outward with the glacial advance, but the action of sapping is horizontal and backward. It is seldom lateral, and then only for a brief space. The flat valley bottom, as well as the parallel valley walls (where sub-

sequent scour has not dulled their upright profiles), are by-products of recession of the transverse cliff.

So long as, along any advancing line, it continues active, sapping will be altogether dominant over scour, accomplishing large results in excavation ; but its action, apparently, is by successive attacks, from point to point, and has relatively brief duration. Its forms, thereafter, arrested in development, become obsolescent under the continuous action of scour, and the rounding-off of angles puts them seemingly into the category of scour forms.

The following hypothesis is advanced as to the cause of glacial sapping : The glacier protects its bed against the sharp variations of temperature which, by mechanical disintegration, waste exposed slopes. At the same time the covered rock surface is maintained close to zero, Centigrade—a critical temperature. By tearing away at its head from the mountain slope, and by reason of initial irregularities of bed along its line of flow, the glacier is broken across. If the depth of ice be not too great these breaks, or crevasses, will penetrate to the bottom. Along the narrow transverse line of bed, or floor, thus exposed—during summer, while the crevasse is open—there will be oscillations of temperature, between day and night perhaps, accomplishing an alternation of freezing and thawing. This alternation across the freezing point, at the crevasse foot, will be much more frequent than upon the exposed slopes without—a diurnal, rather than a seasonal, change. The crevasse foot will thus be a line of sharply localized and abnormally vigorous weathering, by coarse mechanical disintegration. The glacier is an agent here, directly, only in the removal of waste products. Frost-fracturing acts vertically downward, as well as horizontally backward, into the cliff, which it thus undercuts ; but the products of its downward work are much less readily removed, and failure to remove operates to defeat downward action. Thus the cliff recedes, leaving in its trail an approximately flat and horizontal floor. In the slight unevennesses of this floor, after glacial conditions have passed and the cañon has become emptied, rock-basin lakes accumulate.

By recession at the amphitheatre head—and the glacier makes the amphitheatre, rather than merely occupies it—the amphitheatral wall is carried backward, and divides are cut through. A summit region, upon either slope of which glacial streams are extended, will be trenched by streams heading thus in opposition. A first effect of the meeting of an opposing pair will be the arête, or thin comb—the most evanescent of mountain forms; the final effect will be the col—a low-level pass between walls. The ultimate result of continued glaciation must be truncation of the crest region, close to the lower level of the glacial generation. Transitional forms will be not only the arête and the col, but the aiguille, or minaret, the residual table, the cañon of diverted discharge, the cañon of Yosemite type, and the towering peak of Matterhorn type, against which divergent streams will burrow at their heads, scalloping its base, and maintaining its sinking summit as the sharp apex of a slender and fluted pyramid.

HARVARD UNIVERSITY: STUDENTS' GEOLOGICAL CLUB, DECEMBER 19, 1898.

UNDER the general title, 'Geological Results of the Recent Storm upon the Massachusetts Coast,' five members reported observations. Mr. R. B. Earle described results noted on the Winthrop and Beachmont shores. Winthrop Beach, usually sandy and of gentle slope, bore a series of gravel cusps, terminated on the seaward side by spits that pointed toward the southeast. Whenever these cusps were composed of coarse gravel they were high and near together; when of fine material they were low and far apart. In the Beachmont Bluff, at similar intervals, was a series of cavern-like undercuttings. A portion of the beach, below the Bluff, was covered with heaps of seaweed shaped into cusped forms, but another portion was degraded to a depth of three feet.

Mr. A. W. G. Wilson visited the south shore from Windmill Point to Cohasset Harbor. At the former locality sand and gravel were thrown inland thirty feet. The railroad track that ran close to high-tide level, along the front of the drumlin upon which the town of Hull is located, was protected by a breakwater of granite and diorite blocks. From this breakwater, some

blocks, which weigh approximately a ton or more, were moved back ten feet and raised between one and two feet. Nantasket Beach, in front of Strawberry Hill, was cut down four feet, and back in places twenty feet, for a distance along the beach of five hundred yards. Sections of sewer pipe thus revealed afforded a basis for measurement. At the southern end of Nantasket, where most of the wrecks were washed up, large quantities of *thoroughly rounded*, soft coal were imbedded in the beach sand to a depth of at least ten inches. A short distance east of Gun Rock, half a mile from Nantasket, some houses stand one hundred yards inland and from six to ten feet above normal high water level. Coarse gravel accumulated against these houses in heaps three feet high and buried a neighboring road between two and three feet deep. At Hull and in the region of Gun Rock, where a salt marsh and a pond, respectively, lay back of the beach, new, storm-built beaches have encroached upon the marsh and pond, in the form of well-marked series of gravel spits from one to five feet in height.

Mr. J. M. Boutwell offered three records of height of water. At Lynn Beach the position of pebbles and débris indicates the submergence of its Nahant end. At its Lynn end, according to the statement of an eye witness, the water rose over the road to a depth of three feet and swept completely across the beach. At Milton, in the Neponset River, a rod has been so placed that its top marks the height reached by the high tide of 1851. One eye witness states that during the recent storm the water rose to within three inches of the top of this rod; another affirms that he saw it rise over the top. At the Boston end of the West Boston bridge the water in the Charles River rose to within one inch of the street level. The tide predicted for November 27th was the normal high-tide, ten feet two inches at Boston. Had the storm passed at the time of spring-tide, about two days later, the water would have risen fully a foot higher. As it was, the concomitant effect of an imminent spring-tide, a strong, low pressure area and an onshore wind was to raise the water higher, at some points, than it was during the high tide of 1851. J. M. BOUTWELL,

Chairman.

ONONDAGA ACADEMY OF SCIENCE.

At the November meeting of the Academy Professor P. F. Schneider read a paper on 'Onondaga Whetstones,' giving a short history of the use of whetstones and comparing the various commercial stones. The Labrador stone is found at the southern border of the county and is manufactured in a nearby town. It makes an excellent 'table stone.' The Arkansas stone is also manufactured by the same company, the 60,000 pounds annually shipped here yielding about 20,000 pounds of the finished product.

At the December meeting of the Academy Professor Schneider spoke on 'Palæobotany of Onondaga County,' illustrating his remarks by about a dozen plant remains from the local Silurian and Devonian rocks.

Mrs. L. L. Goodrich spoke on 'Variations in *Trilliums*,' and exhibited specimens ranging from the typical *Trillium grandiflorum* through gradations of petioled leaved forms to extreme forms with purely radical leaves. In nearly all cases the petals were more or less marked with green, and various degrees of reduplication and suppression of floral parts were noted as common occurrences.

Dr. A. A. Tyler spoke on 'The Origin of Species Through Variations,' after which the topics of the evening were discussed by Dr. W. M. Beauchamp and Dr. Hargitt.

H. W. BRITCHER,
Corresponding Secretary.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

At the meeting of the Academy of Science of St. Louis, of January 9, 1899, the following officers were declared elected for the current year: President, Edmund A. Engler; Vice-Presidents, Robert Moore, D. S. H. Smith; Recording Secretary, William Trelease; Corresponding Secretary, Joseph Grindon; Treasurer, Enno Sander; Librarian, G. Hambach; Curators, G. Hambach, Julius Hurter, Hermann von Schrenk; Directors, M. H. Post, Amand Ravold.

Mr. Hermann von Schrenk presented informally the results of a study of a sclerotium disease of beech roots which he had observed in southeastern New York during the past summer.

The sclerotia, which were formed by the webbing together of rootlets by sterile mycelial threads, were stated by the speaker to have apparently no connection with the mycorrhiza of the beech. Mr. von Schrenck's remarks were illustrated by drawings and alcoholic and sectioned specimens.

WILLIAM TRELEASE,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

SCIENCE AND POLITICS.

At the last biennial session of the Legislature of Kansas there was passed what is known as the State uniform text-book law. A commission was appointed whose duty it was to select the text-books of all grades used in the public schools of the State, which were to be furnished at a stipulated price to all pupils. No other texts than the one selected may be used by any school under pain of severe penalties. The law has now been in force for two years and these books are being used by several hundred thousand pupils. So far as I can learn, specialists or experts were not consulted in the choice of the texts. Wide latitude was given to the commission, the one important stipulation being that the books should be cheap! Protests have been made, but in vain—the books must be used in every case where prior contracts are not in force. Let us examine the wisdom of the Kansas Solons in one case; I am told that others are like it.

The text in Physiology used in all grammar grades is one by a C. L. Hoxie, whoever he may be. As he is the author of text-books in Physics, doubtless his name will be familiar to the physicists of the country! The work had the benefit of revision by two high-school teachers of St. Louis. The part they took in the revision ought certainly to elevate them from obscurity.

We can sympathize strongly in the introductory statement by the author that the "value of a thorough knowledge of physiology in all of its departments can scarcely be estimated. If one be well a knowledge of physiology will keep him so. If one be sick the same knowledge will enable him to regain that priceless treasure—good health." One must suspect

that the author is a confirmed invalid! His definition of physiology is certainly unique:

"Physiology proper naturally divides itself into three departments, Anatomy, Physiology and Hygiene." "Bones, like all other organic structures, consist of cells; the cells are more or less of a hexagonal form." He seems especially hazy about the lymphatic system: "The lymphatics perform the office of absorption, chiefly in the skin." At one time he has the lymph 'poured into the blood through the thoracic duct into the *vana cava* in the neck,' but farther on he modifies this by saying that the lacteals 'terminate in two ducts, which open into the large veins, and finally into the heart, one on the right side and the other on the left side of the chest! "The liver performs the double office of separating impurities from the blood and secreting bile." The 'bile acts as a solvent of the fatty portions of food,' while we are informed that 'fat is an oily concrete substance, composed of stearine and elaine!' One of the chief functions of the saliva is to 'quench thirst,' and the 'epiglottis serves to deaden sound!' Among other 'important facts' the author says that the 'heart of quadrupeds lies in the middle line, and not to the left, as in man.' "All reptiles have two auricles and one ventricle." From the fact 'that coagulation is greater in the lower animals' he derives the very interesting conclusion that 'this seems to be a wise provision, since these animals can not stop a flow of blood from a wound by artificial means.'

But enough. These few examples are chosen almost at random. The book contains more poor English, wild and loose statements of fact, errors and absurdities than I ever saw before in a text-book of modern times. One might be amused at such stuff, published as 'science' were it not that tens of thousands of children in this State are compelled to learn it, usually taught by teachers whose ignorance of the subject is greater than that shown by the author himself.

Everywhere that a moral can be lugged in by the ears or tail the baneful effects of the poison alcohol are urged. Can such a book be expected to serve any useful purpose in teaching the principles of temperance?

And this is what politics may do for science in the public schools!

S. W. WILLISTON.

UNIVERSITY OF KANSAS, LAWRENCE.

THE STORING OF PAMPHLETS.

ON reading Professor Minot's explanation of his method of storing pamphlets as given in the issue of December 30th I feel inclined to add a word in commendation of the method. I began using these boxes six or seven years ago and now have 152 upon my shelves. About one-half are devoted to Experiment Station bulletins, the boxes being labeled by States and arranged alphabetically. The other half is used for miscellaneous pamphlets on subjects pertaining to my line of work. The boxes have proved perfectly satisfactory in every way, and as a simple time-saving device they are worth many times the cost. My system of pamphlet arrangement differs in some ways from that adopted by Professor Minot and has been adopted only after trial of several other methods.

Each case is labeled and is also given a number. The pamphlets are numbered consecutively and arranged in the cases, as far as possible, by subjects, and each one is stamped with the number of the case in which it belongs. The location of each is, therefore, permanent. It is always returned to the same case and the same relative position as regards others in the case.

In a convenient drawer of my desk is a card index where all papers are recorded by author and by title. Each card carries the pamphlet number and the case number, thus indicating the exact location of the pamphlet desired. Often a dozen or more pamphlets may be in use, scattered over my work table for several days; when ready to be returned, the numbers direct to the case and to the correct position within the case. If each pamphlet contained but a single article the alphabetical arrangement would be the most simple; but many contain more than one title, often several, and not infrequently by different authors. These were a source of annoyance until the present system was adopted. I do not find the system cumbersome, and the time employed in keep-

ing it up is saved many times over by the facility with which reference is made.

CHARLES S. CRANDALL.

THE STATE AGRICULTURAL COLLEGE,
FORT COLLINS, COLORADO.

ZONE TEMPERATURES.

MY attention has been recently called by Dr. Walter H. Evans, of the United States Department of Agriculture, to an error in the temperature tables accompanying my paper on the 'Laws of Temperature Control of the Geographic Distribution of Animals and Plants,' an abstract of which was printed in my recent bulletin on 'Life Zones and Crop Zones.' The error in question relates to the effective temperature or 'sum of normal mean daily temperature above 6°C.' In the tables bearing the above heading the quantities actually given are the sums of normal mean daily temperatures (*without deducting* the 6°C. each day) for the period during which the mean daily temperature exceeds 6°C.

The temperature data, as stated on the first page of my original paper, were furnished by the Weather Bureau. Not being of a mathematical turn of mind, I did not detect the error until my attention was called to it by Dr. Evans. Corrected tables will be given in the next edition of 'Life Zones and Crop Zones.'

C. HART MERRIAM.

PHYSICAL NOTES.

DR. OLIVER LODGE, in a recent paper before the Institution of Electrical Engineers, speaks of the probable importance of leakage currents in the usual methods of telegraphing by magnetic inductance through space. This form of wireless telegraphy has usually been accomplished with long parallel wires on poles and ground returns. In some experiments made by Stephenson near Edinburgh horizontal coils of wire were used and signals transmitted half a mile with a morse key in one coil and a telephone receiver in the other. Mr. Lodge used similar coils covering areas of about 4,500 square yards and transmitted signals about two miles. The characteristics of his method are the use of an alternating current of a rather high frequency, about 380, and the tuning of the line to this frequency by the use of con-

densers, that is, the balancing of the inductance so that the current becomes equal to the induced E. M. F. divided by the ohmic resistance. As a result, he gets much greater effects than where the current is principally determined by the inductance of the circuits. This he shows by mathematical determination will be the case, the value of $2\pi \times$ the frequency, coming in one instance in the denominator, while in the other it comes in the numerator of the expression giving the ratio between the secondary current and the impressed primary E. M. F.

F. C. C.

CURRENT NOTES ON METEOROLOGY.

THE WINDWARD ISLANDS HURRICANE OF SEPTEMBER, 1898.

THE practical advantages gained by the establishment of the new West Indian Service of our Weather Bureau are forcibly illustrated in the account of the hurricane of September 10th and 11th last, published in the September number of the *Monthly Weather Review*. The Weather Bureau Observer at Bridgetown, Barbados, sent a special cable to Washington at 12:40 p. m., September 10th, announcing the approach of a hurricane. Warnings were immediately cabled to Weather Bureau stations in the Lesser Antilles, and the officials in charge were directed to give the widest possible distribution to the warnings. Advisory messages were sent to other islands, as far west as Jamaica and eastern Cuba, to points on the South American coast of the Caribbean Sea, and to Admiral Watson's fleet, lying in the harbor of Caimanera, Cuba. The careful reports of the Weather Bureau Observers at Kingston, Jamaica, at St. Kitts and other stations also made possible an early and complete record of the hurricane.

In this connection another paper, in the same number of the *Review*, is of interest. It concerns the telegraph service of the Weather Bureau with the West Indies, and is illustrated by a chart showing the routes of the submarine cables over which reports are transmitted and the points at which the cables connect with the land lines.

At the December meeting of the Royal Meteorological Society (London) Captain A. Carpenter, R. N., gave an account of this disastrous hurricane.

Its diameter was 80 miles as it approached Barbados, and 170 miles after leaving St. Vincent. The actual storm center, in which the force of the wind greatly increased, was only 35 miles in diameter until St. Vincent was passed, but after that the strength of the wind extended to 170 miles from the center. The diameter of the calm vortex was not less than four miles. The storm was accompanied by very heavy rainfall, the amount at St. Vincent being about 14 inches in 24 hours. In Barbados 11,400 houses were swept away or blown down and 115 lives were lost, and in St. Vincent 6,000 houses were blown down or damaged beyond repair, and 200 lives were lost.

PROBABLE STATE OF SKY ALONG THE PATH OF
THE ECLIPSE, MAY 28, 1900.

PROFESSOR F. H. BIGELOW, in the *Monthly Weather Review* for September, considers the probable state of the sky along the path of the total eclipse of the sun, May 28, 1900. His conclusion is as follows: "It would be much safer for the eclipse expeditions to locate their stations in the northern portions of Georgia and Alabama, upon the southern end of the Appalachian Mountains, where the track crosses elevated areas, than nearer the coast line in either direction northeastward toward the Atlantic coast, or southwestward toward the Gulf coast; on the coast itself the weather is more unfavorable than in any other portion of the track." Professor Bigelow's paper is illustrated by means of a chart.

NOTES.

THE November number of *Climate and Crops, Illinois Section*, in commenting upon the statistics of losses by lightning in Illinois during 1898, says: "A survey of the reports shows a very marked increase in the loss of stock due to the wire fence, and the urgent need of frequent ground wires in those in use." (See note in this connection in *SCIENCE*, Dec. 2, 1898, p. 785.) R. DEC. WARD.

HARVARD UNIVERSITY.

CURRENT NOTES ON ANTHROPOLOGY.

THE OLDEST SKULL-FORM IN EUROPE.

In the *Centralblatt für Anthropologie* (Heft. 4, 1898) are some abstracts touching the skull-

form which is believed to be the oldest in Europe. It is represented most perfectly by the remains found at Spy. The characteristics are: uncommon length, moderate width, very limited height, retreating forehead, prominent but depressed supra-orbital ridges and narrowed post-orbital diameter. Dr. Fraipont argues sharply for the genuine ancient character of the Neanderthal skull, and Dr. Schwalbe does not regard that found at Egisheim as a good type. As for modern examples simulating the Neanderthal skull the latter asserts that, while they may resemble it in one or another point, they never present the group of inferior criteria which characterize its measurements.

THE SUPPOSED 'OTTER TRAP.'

DR. ROBERT MUNRO in his excellent work, *Prehistoric Problems*, has a chapter on a curious object found in the peat bogs of Europe, from Italy to Scotland and North Germany. He has recently supplemented that chapter by an article describing further examples. (*Jour. Roy. Soc. Antiquaries of Ireland*, September, 1898.)

The object is a thick board or plank, two to three feet long, in the center of which is an oblong aperture four to six inches wide, closed by one or two valvular doors. The purpose of this arrangement is obscure. Dr. Munro argues that it is an otter or beaver trap, while others have explained it as a boat-model, a sluice-box, a float for lines, etc.

The suggestion which I would offer for its use differs from any I have seen. It is doubtful that the valves could hold firmly an otter or any such animal. The purpose for which it would be entirely suited would be that of the inlet to a fish-weir. The valves, opening inward, would allow the fish to enter and would prevent their exit. Similar, though not identical, devices are in common use.

ANTHROPOLOGICAL STUDY OF FEEBLE-MINDED
CHILDREN.

IN a supplement of the 48th annual report of the managers of the Syracuse State Institution for feeble-minded Children, Dr. Alex. Hrdlicka presents an anthropological study of a long series of these unfortunates. It includes their family conditions, the supposed etiolog-

ical factors of the deficiency, and the physical examination of the subjects.

While the report is very instructive on many individual features, it admits of few general conclusions other than that we need much more extended investigations than have heretofore been prosecuted, in order to reach positive opinions as to the causation and the status of the feeble-minded; and this is Dr. Hrdlicka's own decision (p. 95).

D. G. BRINTON.

UNIVERSITY OF PENNSYLVANIA.

SCIENTIFIC NOTES AND NEWS.

M. VAN TIEGHEM, the eminent botanist, succeeds M. Wolf as President of the Paris Academy of Science, while M. Lévy has been elected Vice-President.

At its meeting on January 11th the American Academy of Arts and Sciences elected Charles Doolittle Walcott, of Washington, an Associate Fellow in place of the late Professor James Hall, and Oliver Heaviside, of Newton Abbot, England, a Foreign Honorary Member.

It is proposed to erect a monument in memory of Félix Tisserand, Member of the Institute of France, and of the Bureau of Longitude, and Director of the Observatory of Paris, at Nuits-Saint-Georges (Côte-d'Or), his native place. Subscriptions will be received at Nuits-Saint-Georges, by M. Desmazes, Receveur Municipal; at the Observatory of Paris, by M. Fraissinet, and at Dijon, by M. Ragot (rue Colson).

SURGEON-GENERAL STERNBERG is at present in Cuba inspecting the hospitals and arranging for a new yellow fever hospital and a depot for medical supplies in Havana.

THE Permanent Secretary of the American Association for the Advancement of Science, Dr. L. O. Howard, would be glad to learn of the address of José de Riviera, who was elected a life member of the Association at the Boston meeting of 1880.

THE Chemical Society of Washington, at the annual meeting held on Thursday, January 12, 1899, elected the following officers for the ensuing year: President, Dr. H. N. Stokes; Vice-Presidents, Dr. P. Fireman, Dr. H. C. Bolton; Secretary, Mr. William H. Krug;

Treasurer, Mr. W. P. Cutter; Executive Committee, the above officers and Dr. C. E. Munroe, Dr. E. A. de Schweinitz, Mr. Wirt Tassin and Dr. F. W. Hillebrand, *ex-officio*.

PROFESSORS VON KUPFER, of Munich; F. Klein, of Göttingen, and E. Fischer, of Berlin, have been made members of the Bavarian Maximilian Order of Science and Art.

PROFESSOR M. E. COOLEY, of the engineering department of the University of Michigan, who has been Chief Engineer on the United States auxiliary steamer Yosemite since the outbreak of the Spanish-American war, will return to the University in time to begin work with the second semester. He was detached from the Yosemite December 23d, since which date he has been doing temporary work at the League Island Navy Yard. He expects to be relieved from duty by the first of next month.

MR. WM. T. HORNADAY, Director of the New York Zoological Park, has been elected a corresponding member of the London Zoological Society.

Nature states that Mr. Frederick G. Jackson, the leader of the Jackson-Harmsworth expedition, has been presented with a first class of the Royal Order of St. Olaf by King Oscar of Sweden and Norway.

THE Paris Academy of Sciences has nominated for the chair of chemistry in the Conservatoire des Arts et Métiers as first choice M. Florent, and as second choice M. Joannis.

MR. JOHN BARROW, F.R.S., the author of works on travel and physiography, has died at the advanced age of 91 years.

PROFESSOR JOSEPH BALDWIN, who held the chair of pedagogy in the University of Texas, died on January 14th, aged 70 years.

At the annual meeting of the Indiana Academy of Science held at Indianapolis during Christmas week, Mr. W. W. Woollen announced that he had set aside forty-four acres of land situated nine miles from the center of Indianapolis, for a garden of birds and botany. He proposes to develop the garden and present it to the city of Indianapolis, to be placed under the control of the Superintendent of Schools, the President of Butler College, and the President

of the Academy of Science, for the use of the bodies represented by them.

THE Association for maintaining the American women's table at the zoological station at Naples announces that it is prepared to receive applications for use of the table, which should be addressed to the Secretary, Miss Ida H. Hyde, 1 Berkeley St., Cambridge. The Executive Board has at its disposal a small fund for the aid of scholars of the Association who may need assistance to meet the expenses of travel and of residence in Naples. The first two scholars of the Association were Professor Mary Alice Wilcox, of Wellesley College, and Miss Florence Peebles, European Fellow of Bryn Mawr College.

THE late Baron Ferdinand Rothschild has bequeathed to the British Museum art collections valued at \$1,500,000.

THE French Society for the encouragement of national industry has been presented with a sum of 20,000 fr. by M. Gilbert.

JUDGE JOHN HANDLEY, of Scranton, Pa., left \$250,000 for a public library at Winchester, Va., and made the city his residuary legatee. It has been decided in the Courts that the latter bequest is valid, and the city will receive about \$250,000 additional to the public library.

MR. ANDREW CARNEGIE has offered to give \$250,000 for the construction of a building for the Washington Public Library if Congress will furnish a suitable site and provide for the maintenance of the library.

THE Imperial Academy of Military Medicine, St. Petersburg, celebrated on December 30th the centenary of its foundation, in the presence of official delegates from Germany, France and other nations. The Director of the Academy, Professor Ponchatine, made an address, giving a brief history of the institution and an account of the work that it had accomplished.

THE Proceedings of the second annual meeting of the Association of Experiment Station Veterinarians, held at Omaha, Neb., September 8, 1898, have recently been published by the U. S. Department of Agriculture (Bureau of Animal Industry, Bul. No. 22). Among the papers are those on 'Growing Tubercle Bacilli for Tuberculin,' by C. A. Cary; 'Feeding Wild

Plants to Sheep,' by S. B. Nelson, and 'Laboratory Records for Veterinarians,' by A. W. Bitting.

THE meeting of teachers of chemistry held at the University of Michigan on December 27 and 28, 1898, proved to be of great interest. A considerable number of high schools in Michigan were represented in the meeting. Among the institutions sending teachers were the University of Wisconsin; Lake Forest University; Chicago University; Notre Dame, Ind.; Ohio State University; Kenyon College, Ohio; Otterbein University, Ohio; Olivet College, and Lewis Institute, Chicago. There were also reports and papers from the University of Chicago. The discussions were limited to the subjects and methods of teaching chemistry in high schools and colleges.

AN International Conference on Child Study will be held in Buda-Pesth next September.

It is reported from Sydney that the private yacht Lady St. Aubyn has discovered some relics of the French navigator La Pérouse at Vanikoro Islands. The objects found include flint-lock muskets and Spanish and French coins.

THE Russian Imperial Geographical Society announces that neither the expedition of Stradling nor of Brede has been able to find in Siberia traces of Andrée. In the meanwhile an expedition has been organized at Copenhagen, under the direction of Dr. Daniel Brunn, to search for traces of Andrée in eastern Greenland.

THE Division of Statistics of the U. S. Department of Agriculture reports that the acreage devoted to cotton in the United States in 1897 was 24,319,584, an increase of 1,046,375 over that for 1896. The number of bales produced was in 1897 10,897,857, an increase of 2,365,152 bales. There was an increase in almost every State, being especially noticeable in Arkansas and Indian Territory. The investigation of the amount of cotton purchased by mills located in the cotton-growing States shows that 1,277,674 bales were taken from the current crop. This is 295,683 bales, or 30.1 per cent. more than was purchased by these mills in 1896-97. Without an exception every State

shows increased purchases, the per cent. of increase ranging from 7.7 in Louisiana to 65.2 in Missouri. In the States of greatest consumption the increase is especially marked, that in Alabama being 41.9, in Georgia 25.2, North Carolina 36.6, and South Carolina 33.8 per cent. During the year there were 425 mills in operation, as compared with 402 in 1896-97.

THE Board of Health of New York City has obtained a conviction in the Courts for violating the law forbidding the burning of soft coal, a fine of \$25.00 being imposed.

A CORRESPONDENT writes to the *London Times*: "As it is just 100 years since Pestalozzi began at Stanz, on the Lake of Lucerne, the work among the orphan children which so deeply influenced the aims and methods of elementary education in German-speaking Europe and indirectly in Great Britain and America, it is intended to celebrate the centenary by a public meeting, which will be held, by permission of the Council, in the large hall of the College of Preceptors, Bloomsbury-square, on Wednesday, January 4th, at 8 p. m. Though many of Pestalozzi's hopes have been unfulfilled and modern psychology is far from confirming some of his attempted generalizations, his labors at Stanz will always form one of the most inspiring chapters in educational history. His work there emphasized the fact that religious influences are essential to all education which aims at strengthening the will and at elevating character, and that no educational instrument is so powerful as the self-devotion of the teacher. Sir Joshua Fitch will preside at the meeting, at which short addresses will be given by Professor Wilhelm Rein, of the University of Jena; Lady Isabel Margesson; Miss Herford (Manchester), and Messrs. A. Sonnenschein, R. L. Morant, E. Cooke and others."

UNIVERSITY AND EDUCATIONAL NEWS.

THE sum of £115,000 has been subscribed towards establishing a university at Birmingham.

THE late Henry Clark Warren, of Boston, an accomplished Oriental scholar, has left to Harvard University a large sum principally for the Sanscrit department, but including \$10,000 for the Peabody Museum of American archæology

and ethnology and \$10,000 for the Dental School. The Sanscrit department is to have \$15,000 for the endowment of the Harvard Oriental Series, and the balance, which is said to be large, is to be used for the benefit of the department.

HARVARD UNIVERSITY receives \$5,000 by the will of the late Susan B. Lyman, Dedham, Mass., and \$10,000 by the will of the late Mrs. Mary Ann P. Weld, of Boston, the latter sum being for the purpose of founding a Christopher Minot Weld Scholarship, which is to be awarded each year to some worthy student.

THE Teachers College of Columbia University has received an anonymous gift of \$10,000.

COLUMBIA UNIVERSITY has established sixty-three benefactors' scholarships and twenty-two faculty scholarships, in order to place the remission of tuition fees hitherto made on a more permanent basis.

THE appropriation of the State for the University of Georgia has this year been reduced by \$14,000. The appropriation for the schools has also been greatly reduced.

WE have received the calendar of the Tokyo Imperial University for 1897-98, which is printed in English. There were 2,239 students in the University, distributed as follows: University, 177; the College of Law, 744; College of Medicine, 813; College of Engineering, 386; College of Literature, 279; College of Science, 105; College of Agriculture, 235. There are 90 professors and 41 assistant professors. The library now contains about 223,000 volumes. The *Journal* of the College of Science, established in 1887 and now in its tenth volume, has published many important contributions, which are written in English or in German.

AT Harvard University, Dr. R. W. Willson has been appointed assistant professor of astronomy, and Dr. C. R. Sanger, assistant professor of chemistry.

MR. L. B. WILSON has been appointed demonstrator in pathology and bacteriology in the University of Minnesota.

DR. WILHELM THIERMANN, of the Technical Institute at Hanover, has been made professor.

SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; J. LE CONTE, Geology; W. M. DAVIS, Physiography; O. C. MARSH, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; HENRY F. OSBORN, General Biology; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; J. McKEEN CATTELL, Psychology; DANIEL G. BRINTON, J. W. POWELL, Anthropology.

FRIDAY, JANUARY 27, 1899.

TRUTH AND ERROR.*

CONTENTS:

Truth and Error:—

PROFESSOR W. K. BROOKS..... 121

PROFESSOR LESTER F. WARD..... 126

Inconsiderate Legislation on Birds...... 137

Eleventh Annual Meeting of the Geological Society of America (II.): PROFESSOR J. F. KEMP..... 138

The Winter Meeting of the Anthropological Section of the American Association: A. L. KROEBER... 145

Scientific Books:—

Dana's Text-Book of Geology: PROFESSOR W. B. CLARK. *Mivart on the Groundwork of Science:* PROFESSOR J. E. CREIGHTON. *Jones on Freezing-point, Boiling-point and Conductivity Methods:* J. E. G. THORP's *Outlines of Industrial Chemistry:* PROFESSOR W. A. NOYES. *Durand's Aperçus de taxonomie générale:* F. A. LUCAS. *Books Received.*..... 147

Scientific Journals and Articles...... 151

Societies and Academies:—

Geological Society of Washington: DR. W. F. MORSELL..... 152

Discussion and Correspondence:—

Matter, Energy, Force and Work: PROFESSOR SILAS W. HOLMAN. *Zoological Bibliography:* F. A. BATHER..... 154

Notes on Inorganic Chemistry: J. L. H..... 155

Zoological Notes...... 156

Current Notes on Anthropology:—

Another Mexican Codex; The Progressive Woman; The Seat of the Soul: PROFESSOR D. G. BRINTON..... 156

Collections of the Provincial Museum of Victoria, British Columbia: DR. HARLAN I. SMITH..... 156

Scientific Notes and News...... 157

University and Educational News...... 160

"If to do were as easy as to know what were good to do, chapels had been churches, and poor men's cottages princes' palaces. It is a good divine that follows his own instruction. I can easier teach twenty what were good to be done than be one of the twenty to follow mine own teaching."

"Science," says Powell, "deals with realities. These are bodies and their properties. Known realities are those about which mankind have knowledge; scientific research is the endeavor to increase knowledge, and its methods are experience, observation and verification."

While most men of science admit all this as good precept, history warns them that they must be on their guard, lest they fall unknowingly into the dream-land of the 'philosophers;' for our author tells us that "The dream of intellectual intoxication seems to some to be more real and more worthy of the human mind than the simple truths discovered by science."

While rebuking the metaphysicians, our author does not spare those men of science who assert that while science deals with the *properties* of matter the real nature of matter—what it is in itself—is quite unknown: "As though its properties did not constitute its essential nature."

"Would a sane person," he asks, "speak

* By J. W. Powell. Chicago, The Open Court Publishing Co., 1898.

MSB. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

of the horse and head, the horse and body, the horse and legs, the horse and tail, and then consider the horse as one thing, the head, body, legs and tail as other things? Yet this is the error of those who consider matter as one thing and properties as other things."

"As it is of matter, so it is of space: One man sees the disc of the moon when it is riding high as having the size of the top of a teacup, another as large as a cartwheel. But the moon will be seen larger than a barn if it is seen behind a distant barn, or it may seem to be as large as a great mountain when it rises behind such a mountain. As the moon rides the heavens it seems to be this side of the surface of the sky, although we know that there is no such surface. Such habitual judgments of space and time seem to contradict each other. By a natural process of fallacious judgment the idea of space as void is developed as an existing thing or body. This is the ghost of space—the creation of an entity out of nothing. The space of which we speak is occupied. We can by no possibility consider true space or void as a term of reality. If we reason about it mathematically, and call it x , the meaning of x in the equation is finally resolved by expressing it in terms of body as they are represented by surface. This non-space has no number; it is not one or many in one—it is nothing. It is not extension as figure or structure—it is nothing. The fallacy concerning space is born of careless reasoning. No harm is done by this popular misconception of space until we use it in reasoning as a term of reality; then the attributes of space may be anything because they are nothing."

"The universe is a concourse of related factors composed of related particles. A relation cannot exist independent of terms. We may consider a relation abstractly, but it cannot exist abstractly. To affirm a re-

lation the terms must be implied. When an abstract is reified, that is supposed to exist by itself independent of other essentials, and the illusion is entertained that there is something independent of the essentials which supports them, a mythology is created so subtle as to simulate reality. So when relations are reified and supposed to exist independent of terms the mind is astray in the realm of fallacies."

All this seems to me to be so important and significant that it cannot be said too often, for it is all so essential to clear thinking upon the significance of science that I believe the author has done good service in repeating it, although it was all said long ago in still simpler and clearer words.

Berkeley tells us that "what seems to have had a chief part in rendering speculation intricate and perplexed, and to have occasioned innumerable errors and difficulties in almost all parts of knowledge, is the opinion that the mind hath a power of framing *abstract ideas* or notions of things. He who is not a perfect stranger to the writings and disputes of the philosophers most needs acknowledge that no small part of them are spent about abstract ideas. These are in a more especial manner thought to be the object of those exercises which go by the name of Logic and Metaphysics, and of all that which passes under the notion of the most abstract and sublime learning. Whether others have this wonderful faculty of abstracting their ideas they can best tell; as for myself I dare be confident I have it not." ('Human Knowledge,' Introduction, 6-10.)

"I am tempted to think nobody else can form these ideas any more than I can. Pray, Alciphron, which are those things you would call absolutely impossible?"

"Such as include a contradiction."

"Can you form an idea of what includes a contradiction?"

"I can not."

"Consequently, whatever is absolutely impossible you cannot form an idea of?"

"This I grant."

"But can a color or a triangle, such as you describe these abstract general ideas, really exist?"

"It is absolutely impossible such things exist in nature."

"Should it not follow, then, that they can not exist in your mind, or, in other words, that you cannot conceive or frame an idea of them? I do not perceive that I can, by any faculty, whether intellect or imagination, conceive or form an idea of that which is impossible and includes a contradiction." (Alciphron VII., 6.)

"I am of a vulgar cast, simple enough to believe my senses and to leave things as I find them. To be plain, it is my opinion that the real things are the very things I see and feel and perceive by my senses. These I know and, finding they answer all the necessities and purposes of life, have no reason to be solicitous about any other unknown beings. A piece of sensible bread, for instance, would stay my stomach better than ten thousand times as much of that insensible, unintelligible real bread you speak of. It is likewise my opinion that colors and other sensible qualities are in the objects. I cannot, for my life, help thinking that snow is white and fire hot. Away, then, with all that skepticism, all those ridiculous philosophical doubts. I might as well doubt my own being as the being of those things I actually see and feel." (Three Dialogues, III.)

While we are unable to doubt the being of those things we see and feel, we do continually doubt or question the evidence of our senses, for error and illusion and hallucination are, unfortunately, as real as truth; and the part of Powell's book which deals with illusions is that which the reader will find most attractive and suggestive.

"When a youth, as I was breaking prairie with an ox team, my labor was interrupted by a rattlesnake, and, during the day, I saw and killed several of these serpents. At one time the lash of my whip flew off. In trying to pick it up I grasped a stick. The fear of being bitten by a snake, and the degree of expectant attention to which I was wrought, caused me to interpret the sense impression of touch as caused by a rattlesnake. At the same time I distinctly heard the rattle of the snake."

"A soldier in the suspense which precedes the battle, when sharpshooters are now and then picking off a man, may have his gun or his clothing touched by a rifle ball and in the suspense of the occasion may imagine that he has received a serious, perhaps a deadly wound, and may shriek with pain. A mustard plaster on the head may cause a man to dream of an Indian conflict in which he is scalped, as I have observed."

All savages believe that hallucinations are a means of divination, and, as many intoxicants produce hallucinations, all of the North American tribes make use of these, supplemented with many rites, such as dancing, singing, ululation, the beating of drums, and the tormenting of the body by various painful operations, all designed to produce ecstatic states and the consequent hallucinations.

If the Society for Psychical Research were to make a census of those who believe that hallucinations often reveal the unknown past or future, Powell tells us that they would find among the North American Indians one hundred per cent. ready to testify to the truth of this opinion.

Erroneous judgments once made may be repeated in perpetuating fallacies, and myths are invented to explain them. Then the myths become sacred, and the moral nature is enlisted in their defense.

"The stars were seen to move along the firmament, or the surface of a solid, from

east to west, as men run along the surface of the earth at will. But the heavenly bodies move by constantly repeated paths, and so primitive man invents myths to explain these repeated paths."

"Fallacies are," as our author clearly points out, "erroneous inferences in relation to things known. If there were no realities about which inferences are made, fallacies would not be possible. The history of science is the discovery of the simple and the true; in its progress fallacies are dispelled and certitude remains."

These extracts from Powell's book will show how much that is valuable and suggestive and instructive is to be found in it. I regret that I am forced to form a very different estimate of the constructive part of the book, for, as the author expounds his own system of philosophy, he seems to me to be one of those ungracious pastors who, while pointing out to others the steep and thorny way, themselves the primrose path of dalliance tread, and reckon not their own read.

The book begins with a delightful and instructive anecdote of a party of Indians throwing stones across a cañon. The distance from the brink to the opposite wall did not seem very great, yet no man could throw a stone across the chasm, though Chuar, the Indian Chief, could strike the opposite wall very near its brink. The stones thrown by others fell into the depths of the cañon. "I discussed these feats with Chuar, leading him to an explanation of gravity. Now Chuar believed that he could throw a stone much farther along the level of the plateau than over the cañon. His first illusion was thus one very common among mountain travelers—an underestimation of the distance of towering and massive rocks when the eye has no intervening object to divide space into parts as measure of the whole."

"I did not venture," says our author, "to

correct Chuar's judgment, but simply sought to discuss his method of reasoning."

He explained that the stone could not go far over the cañon, because the empty space pulled it down, and, interpreting subjective fear of falling as an objective pull, he pointed out how strongly the empty void pulls upon the man who stands on the brink of a lofty cliff.

"Now, in the language of Chuar's people, a wise man is said to be a traveler, for such is the metaphor by which they express great wisdom, as they suppose that a man must learn by journeying much. So in the moonlight of the last evening's sojourn in the camp on the brink of the cañon, I told Chuar that he was a great traveler, and that I knew of two other great travelers among the seers of the East, one by the name of Hegel, and another by the name of Spencer, and that I should ever remember these three wise men, who spoke like words of wisdom, for it passed through my mind that all three of these philosophers had reified void and founded a philosophy thereon."

The system of philosophy which it is the aim of this book to expound is, so far as I can gather it from a single reading, about as follows:

"It was more than chance," our author tells us, "that produced the decimal system, for the universe is pentalogic, as all of the fundamental series discovered in nature are pentalogic by reason of the five concomitant properties. The origin of the decimal system was the recognition by primitive man of the reciprocal pentalogic system involved in the two hands of the human body." P. 112.

"Thus, in geonomy, p. 43, we deal with an earth composed of five encapsulated globes enclosing a nucleus, and presenting: (1) the centrosphere, (2) the lithosphere, (3) the hydrosphere, (4) the atmosphere, (5) the ethersphere."

"In the human mind, again, we have the

five psychic faculties: (1) sensation, (2) perception, (3) apprehension, (4) reflection and (5) ideation." P. 418.

"These five psychic faculties arise in the mind through the cognition of the five properties of the ultimate particles of matter. Every body, whether it be a stellar system or an atom of hydrogen, has certain fundamental characteristics found in all. These are number, space, motion, time (p. 13), and (p. 14) the fifth property here called judgment."

"All particles of plants, soils and stars have judgment as consciousness and choice; but having no organization for the psychical functions, they have not recollection or inference; they, therefore, do not have intellections or emotions. Only animal beings have these psychical functions. Molecules, stars, stones and plants do not think; that which we have attributed to them as consciousness and choice is only the judgment of particles, but it is the ground, the foundation, the substrate of that which appears in animals when they are organized for conception." P. 413.

"These things are necessary to a primitive judgment: First, a sense impression; second, a consciousness of that impression; third, a desire to know its cause; fourth, a choice of a cause; fifth, a consciousness of the concept of that cause; sixth, a comparison of one conscious term with the other; and seventh, a judgment of likeness or of unlikeness."

For all I know, that which chemists call affinity may be the 'choice of particles to associate in bodies.' All the chemist tells us of the matter is that the word 'affinity' is a sign or symbol to generalize his observations and experiments, and it is clear that this is no reason why he who finds reason to do so may not regard it as evidence of consciousness and choice. The question the chemist is likely to ask is whether Major Powell can so play on the

emotions of an atom of hydrogen as to persuade it to do anything which we have not every reason to expect in course of nature. If he cannot do this his hypothesis is worthless, not because we can disprove it, but because we find no evidence of its truth and no value in its practical application. In fact, it seems to me to be one of the 'reified voids' of which he has warned us.

"The Utes say that the Sun could once go where he pleased, but when he came near the people he burned them. Tevots, the Rabbit-god, fought with the Sun and compelled him to travel by an appointed path along the surface of the sky, so that there might be night and day."

Truly, "It is a good divine that follows his own instruction. If to do were as easy as to know what were good to do, chapels had been churches, and poor men's cottages princes' palaces. I can easier teach twenty what were good to be done than be one of the twenty to follow mine own teaching."

Powell tells us that he has been robbed of his 'beautiful world' by Bishop Berkeley, but his attempt to neutralize the evils of 'idealism' by a new philosophy seems to me to be anything but a happy one, for the application of his own principles to his system of philosophy seems to carry idealism to dizzy heights where even Berkeley never dared to soar.

If every particle of matter has conscious judgment of number, space, motion and time, as he tells us that it has, what becomes of these concomitant properties? Why may not an ultimate particle assert that, while it cannot doubt the reality of the number, space, motion and time of which it is conscious, belief in these properties, as distinct from the judgment of particles, 'reifies a void' and carries us into the realm of 'ghosts,' since the essence of these properties is to be perceived or known, in-

asmuch as every particle knows them, and it is only as known that they exist.

According to our author's own principles and assumptions, space or time, or number or motion, which are not the consciousness of particles are but the ghosts of judgment, the creation of entities out of nothing, for if he is right the *esse* of these properties must be *percipi*.

It must not be inferred that I am myself an idealist, for nothing could be farther from the truth. I seek to be neither an idealist nor a materialist, nor a realist nor a monist, but a naturalist, believing that it will be time to have an opinion as to the relation between mind and matter after we have found out.

For all I know to the contrary, Powell may be right, and every particle of matter may have judgment as consciousness and choice; but the test of truth is evidence, and not the absence of disproof, and belief in the judgment of particles does not concern me.

Our author's belief that all mind is matter in motion, and all matter in motion mind, or, at least, the raw material of mind, is not new. In fact, it seems to be the most characteristic 'philosophy' of our day.

"All systems of philosophy are vanity," say the students of science; but to Sam Weller's question: "What is your particular vanity?" they all, with one accord, begin to cry 'Monism!'

If I seem to some to have devoted more space to this new book on 'philosophy' than it deserves; if I sit patiently among the audience, listening attentively as the philosophers play out their little plays; it is because of my hope that they may destroy each other like Kilkenny cats before the curtain drops, and that, in the last act, they who are no philosophers, but simple honest folks, may come by their own and live at ease.

Because of this hope I study the philoso-

phers as well as I can that I may be the better able to do my part in bringing the desired end about.

W. K. BROOKS.

JOHNS HOPKINS UNIVERSITY.

TRUTH AND ERROR.*

WHATEVER else may be thought or said, all will probably agree that this is a unique and remarkable book. It is intensely original. The author is omniscient and discusses the universe. He treats, like Scaliger of old, *de omni re scibili et quibusdam aliis*. As a specimen of what Kant called 'architectonic symmetry' it probably has never been excelled. It is essentially a philosophic or scientific terminology, but all the terms are new, for even where old terms are used they are invariably given new meanings. The whole book is, therefore, like a foreign language, and the reader's first task is to learn the language. Everything that has been said or done by man is rejected as unsatisfactory and the temple of philosophy is entirely rebuilt out of new bricks cast in new molds. The friction thus caused in reading the book will, therefore, probably deter many from making so great an effort, and one of the objects of a sympathetic treatment should be to point out that the effort will be repaid.

Notwithstanding, however, this 'architectonic symmetry,' the reader has a right justly to complain that his path has not been made as easy as it might have been. The terms are generally defined, it is true, but the definitions are scattered through the text and have to be hunted up many times, as they cannot be remembered on once reading. They should have been all collected together in one place and arranged in alphabetical order as a complete glossary.

* Truth and Error, or the Science of Intellection. By J. W. Powell. Chicago, The Open Court Publishing Company.

As it is, even the index is absolutely worthless. But this is not the worst fault of method. The terms are all interrelated and these interrelations are set forth in divers ways and places in the text, but there are no tabular exhibits of the relations, no graphic or diagrammatic representations. The reader is compelled to carry in his mind all these never-before-heard-of correlations among ideas expressed in wholly unaccustomed language. Whether the author wrote his book from such a condensed scheme or not, he should have drawn it up for the use of others who have never dreamed of these things before. There are indications, however, that he worked entirely from a system evolved in his own mind, and certain passages show that he would have written it better if he had first worked it out in schedules, tables and diagrams.

It is, of course, no part of our duty to undertake the task of tabulating the contents of a book, and few would probably be capable of doing this in the present case, but some attempt or stagger at this seems to be the only way of condensing the enormous mass of matter that the book contains into the compass of a reasonable summary. All the manifold terms employed stand for principles, laws, relations, facts, or phenomena, and these are of widely different character, making it very difficult to find any one term that will embrace them all. For want of a better one, and because little used by the author, let us call them all *principles*. In the second place, all these different kinds of principles are arranged in series, or groups, or classes, each series, group, or class being distinct from any other. In the third place, each series, group or class consists of exactly five terms, standing for five principles, which have a definite and invariable order in the series. The universe is found to be quinary, or, as he calls it, *pentalogic*. Each principle in any

series is related to the ones standing before and after it, but if it has any relation to those of other series it must be to those occupying the same place in the series, and not to any others. There are, therefore, vertical and horizontal relationships, but there can be no diagonal or oblique ones.

There are, at least, twenty of these pentalogic series, each of five terms, which alone would raise the number of terms to one hundred, but there are, of course, many other terms employed in defining and discussing these primary ones. The author nowhere tells us the order in which the numerous pentalogic series should stand, and every one must arrange them as seems most logical. The following attempt in this direction makes no claim to infallibility.

I. It seems clear that the first series must be that which relates to the constitution of matter. The five principles here involved are what he calls the *constituents* of matter, but which he quite as frequently denominates *concomitants*, because, as he explains, they always go together and cannot be separated. These five constituents are: (1) number; (2) space; (3) motion; (4) time; (5) judgment.

II. Without stopping to discuss the first series we may pass to another, the terms of which are correlated, *i. e.*, horizontally related, to the first. It embraces what he calls *essentials* or manifestations, and which, he says, are absolute. They are: (1) unity; (2) extension; (3) speed; (4) persistence; (5) consciousness.

III. Corresponding to these five essentials, which are absolute, there are five *variables*, which are relative, and stand as follows: (1) plurality; (2) position; (3) path; (4) change; (5) choice.

IV. Next in order seem to come what he calls the five *categories*, to which everything in the universe must be referred. These are: (1) kinds; (2) forms; (3) forces; (4) causations; (5) concepts. They also corre-

spond to the five constituents, the five essentials, and the five variables, number by number.

V. Thus far the order of the series seems tolerably clear, but from this point on there may be room for difference. We will regard as the next and fifth series what he calls *particles*, and, without apologizing for the word, proceed to enumerate them as follows: (1) ethereal; (2) stellar; (3) terrestrial (geonomic); (4) vegetal; (5) animal.

VI. He has also a series of what he calls *natural bodies*, which are not precisely parallel with the series of particles. These are: (1) celestial; (2) terrestrial; (3) vegetal; (4) animal; (5) social. The first term here corresponds to the second in the last series, and so on through to the last term, which is not represented in series V.

VII. To the five particles (series V) there are five corresponding *states*, as follows: (1) ethereal; (2) fluid; (3) solid; (4) vital; (5) motile.

VIII. Several series could probably be worked out, representing principles inhering in ethereal, stellar and terrestrial particles, but to find clear statements of them in the book would be a difficult task. The author was anxious to reach the higher, psychological aspects of the subject, and hastened to deal with animal particles. In these he finds five processes, or operations, which he calls *animal principles*. These are: (1) metabolism; (2) reconstruction; (3) motility; (4) reproduction; (5) conception.

IX. These might have been called functions, and for carrying them on there are five corresponding *systems of organs*, as follows: (1) digestive; (2) circulatory; (3) motor; (4) generative; (5) cogitative (not his word).

X. Adhering to the psychic elements, the five *senses* may be next considered. These vary slightly from the traditional five senses in very properly grouping taste and

smell together as one and recognizing the muscular sense: (1) taste and smell; (2) touch; (3) the muscular sense; (4) hearing; (5) sight.

XI. Parallel to these are the five *modes of appeal to the senses*, the senses representing subjective states, modes of appeal objective properties: (1) savors; (2) odors; (3) pressures; (4) sounds; (5) colors.

XII. Major Powell distinguishes between sensations and feelings. The former term he confines to the subjective states residing in the end organs of sense (of course referred to the brain), while the other he restricts to internal states, such as most psychologists recognize as emotional states in a broad sense. Without stopping to show that such a classification is illogical, we may enumerate here what he calls *feeling impressions*, of which there are, of course, exactly five. Expressed adjectively, they are: (1) metabolic; (2) circulatory; (3) motor; (4) reproductive; (5) cognitional. The reader cannot fail to note the close resemblance of these terms to those describing the five systems of animal organs.

XIII. The twelve series of principles thus far enumerated, though falling far short of the whole number that a closer analysis of the book would probably reveal, only bring us up abreast of the subject of mind in its intellectual manifestation, *i. e.*, intellection. The first series to be considered here is that of the *faculties*. Of these there are also five, viz.: (1) sensation; (2) perception; (3) apprehension; (4) reflection; (5) ideation.

XIV. Each faculty probably has five elements or factors, but only three of them seem to be treated from this point of view. In harmony with the fifth and last primary constituent of matter, judgment, all operations of the mind, including sensations, are judgments, and the five *elements of a judgment of sensation* are: (1) choice of a past concept; (2) the consciousness of this

choice; (3) the choice of another concept; (4) a consciousness of this; (5) the comparison of the one with the other.

XV. The five *elements of a judgment of perception*, which he says are the same as for apprehension, are these: (1) consciousness of a concept; (2) choice or recollection of another concept; (3) consciousness of the second concept; (4) comparison of the two concepts; (5) the final judgment.

XVI. In addition to these there are enumerated the five *elements of a judgment proper* (for he does not always use the word judgment in the same sense). They are: (1) consciousness of a sense impression; (2) desire to know its cause; (3) guess or choice as to its cause, reviving the consciousness of the concept of the object chosen; (4) comparison of this second consciousness with the first; (5) judgment of the likeness or unlikeness of the terms compared.

Sixteen cosmic series have now been enumerated, each consisting of five principles expressed by five terms or phrases, the whole forming a kind of diapason rising from the primary constituents of matter and culminating in an act of mind, or intellection. These sixteen series may now, for clearer comprehension, be re-enumerated without the pentalogic terms:

1. Constituents of matter.
2. Essentials or manifestations (absolute).
3. Variables (relative).
4. Categories.
5. Particles.
6. Natural bodies.
7. States of the natural bodies.
8. Animal principles.
9. Systems of organs.
10. Senses.
11. Modes of appeal to the senses.
12. Feeling impressions.
13. Faculties.
14. Elements of a judgment of sensation.
15. " " " " perception.
16. " " " " intellection.

As already remarked, there are many in-

terrelations among the series, and it may be next inquired what are some of the most important of these. All after the first are connected in one way or another with that as the basis of the entire system, but the exact hierarchical dependence of the several series is not worked out. The constituents of matter—number, space, motion, time, and judgment—all belong to everything and are always concomitant in the sense that nothing can lack any of them and have existence. [This is many times repeated, and yet there are passages, as near the bottom of page 13, from which it may be inferred that judgment only inheres in animate bodies.] The essentials, however—unity, extension, speed, persistence, and consciousness—are simply the manifestations of things and constitute the *substrates* of the next series, viz., the variables—plurality, position, path, change and choice. That is, unity is the substrate of plurality, extension is the substrate of position, and so on through the series.

The categories, or classic properties—kinds, forms, forces, causations, and concepts—also correspond, term for term, with the constituents, and several attempts are made to show their interrelations with the other series, but these can best be discussed a little later. The five species of particles—ethereal, stellar, terrestrial, vegetal and animal—are arranged in an ascending series, such that each term after the first contains all that is contained in the preceding term and something in addition, a *differentia* of its own. This *differentia* in every case is related to the corresponding term of the primary series, i. e., the constituents. Particles are organized, and each class is more highly organized than the preceding class in that the next higher constituent is embraced in the organization. In ethereal particles, which, he says, are probably ultimate, numbers alone are organized. In the stars numbers and spaces are organized.

In geonomic bodies numbers, spaces, and motions are organized. In plants numbers, spaces, motions, and times are organized. In animals numbers, spaces, motions, times, and judgments are organized. All this seems to a layman to contradict the definition of the five constituents as necessary concomitants of one another, which would predicate them all even of the first term, or ethereal particles, but the author could probably explain the apparent discrepancy. He has not done so in his book.

He sometimes distinguishes between particles and bodies, and when he does so the bodies are composed of particles, but in his discussion of the natural bodies he expressly excludes the first term of the series of particles, the ethereal, and begins with the second, giving us celestial, terrestrial, vegetal, animal, and social bodies, this last being added apparently to make the necessary five. These bodies are what he calls 'incorporated,' and the order of the terms is an ascending order in the mode or degree of incorporation. This depends upon the character of the respective particles. The terms used describe this as follows :

1. Celestial bodies have molecular particles.
2. Terrestrial bodies have petrologic particles.
3. Vegetal bodies have inorganic particles.
4. Animal bodies have vegetal particles.
5. Social bodies have ideal particles.

He does not use these words in all cases and his terminology is here mixed and more or less confusing, but the above seems to be a fair statement of his meaning.

If we continue to neglect the first class, ethereal bodies, and to begin with the second, celestial bodies, the corresponding states will be: (1) fluid; (2) solid; (3) vital; (4) motile; (5) social. Major Powell never uses the word *social* nor the word *collective*, although he clearly understands this stage of development. His classification of the sciences, or scientific hierarchy, is as follows: (1) etheronomy; (2) astronomy;

(3) geonomy; (4) phytonomy; (5) zoonomy; (6) demonomy.* Why he did not reduce this to five by combining phytonomy and zoonomy under the term *bionomy* (since from the standpoint of biology there is no distinction between them) is rather surprising, but explainable. We are here concerned only with the last term, *demonomy*, which he prefers to *socionomy*, and throughout expresses the conception of collectivity by derivatives from the Greek word *δημος*, using the adjective *demotic*, and even extending it to animal societies, colonies, etc., to which it obviously does not apply.

Passing over the animal principles, or functions, and their respective organs, whose bare enumeration above must suffice, we come to the *senses*. Here it is important to point out that the senses are simply the organs of the categories in their numerical order, thus :

1. Taste (including smell) is the organ of kind.
2. Touch is the organ of form.
3. The muscular sense is the organ of force.
4. Hearing is the organ of causation.
5. Sight is the organ of conception.

Major Powell does not say quite all of this in terms, but it can be safely inferred from the discussion on page 279.

When we come to the *faculties* we have another example of architectonic symmetry. We perceive that the faculties are simply cognitions of the categories, term for term:

1. Sensation is cognition of kind.
2. Perception is cognition of form.
3. Apprehension is cognition of force.
4. Reflection is cognition of causation.
5. Ideation is cognition of conception.

The special treatment of the cosmic series need not be carried farther, but it is of interest to note a few of the more general correlations that may be, with sufficient pains and effort, worked out of different

* Compare the proposed classification given in the *American Journal of Sociology* for July, 1896, Vol. II., p. 82.

passages in the book. In the chapter on Intellections, after all the faculties have been dealt with, the author makes a number of wide sweeps across the whole field to show the numerous and complicated associations that arise among the various series. No tabular exhibits are offered, and the reader is asked to carry in his mind all that has gone before and to put things together for himself. There are many gaps in the terminology which he must supply, and several new series come out that appear not to have been dealt with before. A careful digest of this chapter, and especially of the matter on pages 302 and 303, seem to justify the following table of correlations. The five points of view are: (1) classification; (2) morphology; (3) dynamics; (4) evolution; (5) intellection. If by morphology he means about the same as *homology*, these correspond to five of his chapters, viz., Chapters IX, X, XI, XIII and XVIII. The pentalogies are as follows:

<i>Associations considered in</i>	I. <i>Essentials.</i>	II. <i>Constituents.</i>	III. <i>Categories.</i>	IV. <i>Processes.</i>	V. <i>Products.</i>
1. Classification:	Units.	Numbers.	Kinds.	Series.	Classes.
2. Morphology:	Extensions.	Spaces.	Forms.	Metamorphoses.	Organisms.
3. Dynamics:	Speeds.	Motions.	Forces.	Energies or Powers.	Cooperations.
4. Evolution:	Persistences.	Times.	Causations.	Metageneses.	Developments.
5. Intellection:	Sensations.	Perceptions.	Apprehensions.	Reflections.	Ideations.

It will be perceived that the first three of these columns of associations correspond to series 2, 1 and 3, respectively, viz., essentials, constituents, and categories, except the fifth and last term in each case, where sensation is substituted for consciousness, perception for judgment, and apprehensions for concepts. It will be further observed that the five associations considered in intellection are neither more nor less than the five faculties of intellection. We have, however, in this presentation, two series of principles that have not been previously considered among the pentalogic properties. These are seen in the two last columns.

Some of the terms have been dealt with in previous chapters. The last terms of these series are the two highest faculties, reflection and ideation. Metamorphosis and metagenesis are treated in Chapter V as processes or properties of geonomic bodies, along with other apparently coordinate processes, such as *metalogisis* (an etymologically impossible word) and *metaphysisis* (for which *metaphysis* would have done as well and been correct); but these do not appear in the present connection. Cooperation is the subject of Chapter XII, and development does not so greatly differ from evolution, which is the thing with which it is said to be associated, and is the subject of Chapter XIII. These two new series seem to belong immediately after the categories. The first may be called *processes*: (1) series; (2) metamorphoses; (3) energies or powers; (4) metageneses; (5) reflections. The second may, perhaps, be called *products* or resultant conditions: (1) classes; (2) organ-

isms; (3) cooperations; (4) developments; (5) ideations.

In his final summary (p. 413) the author throws some further light upon his general conception of these interrelated principles. He says that the constituents 'develop into' the categories, and that in so doing both the essentials and the variables 'become' something else, which gives rise to two other new series, here introduced for the first time in any systematic way, although, as in the cases last considered, many of the terms have been discussed, and several of them are the same in form at least as the terms of other series,

but seem here to have entirely different connotations. From his language at this point the following tabular arrangement seems justified :

does not correctly represent the scheme it shows at least that the scheme cannot be understood in its present form. Even should this presentation be accepted in its

<i>Constituents.</i>	<i>Categories.</i>	<i>Essentials.</i>		<i>Varieties.</i>
1. As number develops into	class	unity	becomes kind	and plurality series
2. As space " "	form	extension	" figure	" position structure
3. As motion " "	force	speed	" velocity	" path inertia
4. As time " "	causation	persistence	" state	" change event
5. As judgment " "	conception	consciousness	" recollection	" choice inference.

No names are given to the series represented by the fourth and sixth columns of this table. The first, third and fifth columns are those respectively of the constituents, the essentials and the variables. The second column would correspond to the categories had he not transferred the first term, kind, to the fourth column, and put 'class' in its place. Perhaps the reverse was intended, and this would seem every way more logical. Making this change we would have as one of the new series: (1) class; (2) figure; (3) velocity; (4) state; (5) recollection, and as the other: (1) series; (2) structure; (3) inertia; (4) event; (5) inference.

Twenty of these cosmic series of philosophic principles have now been enumerated. Others could probably be worked out of the text even as it stands, and the author is doubtless conscious of many more. It may be well to repeat that all these correlations are stated in the form of simple discussions and the tabulation has been made from these. Gaps are often left that must be supplied from remote parts of the book, and in a few cases terms are wanting and have had to be selected from the obvious meaning of the context. The author will, therefore, probably criticise these condensations or perhaps repudiate many of them altogether. The only apology that can be made is that this seemed the only way of putting the contents of the book into a form which could be readily grasped, and if it

main aspects it seems doubtful whether it will convey a clear idea to all minds. The terminology is so different from any hitherto employed that attention is constantly arrested on the words at the expense of the meaning. The practice of neoterism has been aptly compared to putting cannon balls inside of bales of cotton whereby their force and effectiveness are destroyed. The strongest writers are not those who use the greatest number of new words, and such a style as Huxley's abundantly proves that the English language, clumsy genetic product as it is, is capable of conveying the deepest scientific and philosophic truth and of expressing the highest and finest shades of thought. The golden rule is never to introduce a new word when an old one will serve the purpose. Major Powell's method reverses this, and he seems never to use a word that has a popular acceptance if he can find a synonym, however rare, or can coin a new term. His use of *demotic* for social, already pointed out, is simply one example in a hundred that might be named. More confusing still, perhaps, is his employment of old words in new senses, as, for example, his use of *apprehension* as a mental faculty, with its opposite *misapprehension*, both of which are in common use with definite though highly derivative significations. His category *kind*, in place of the Kantian *quality*, conveys to the average mind scarcely any idea at all.

We know what his answer to all this

would be, as he never tires of repeating it, viz., that the bane of all thinking is the use of the same word in different senses, whereby the ideas are confused by the sounds of the words. But must we make a new language to obviate this? Is it not due to the muddle-headedness of those who use the words? And will not order come out of this chaos when people learn to think clearly irrespective of words? It may be compared to the agitation about phonetics. Our language has only 26 letters, but over 40 sounds, and yet many of these letters have several sounds. The spelling reformers say this is illogical. There should be just as many letters as sounds, and each letter should have one sound and one only. All this is true, and no one disputes it. But it is a condition and not a theory that confronts us, and it is found that our alphabet, with all its admitted defects, is capable of forming all the words of the language. Both the forms and the meanings of words are products of evolution and have had their history and genesis, and this evolution is constantly going on far more rapidly than the radical reformers suspect in the direction of rationality and logicity. It is, indeed, observed that attempts at hasty reform in orthography tend to arrest natural development and fossilize language, as witness the practice of dropping the syllable *al* in all adjectives in *ical*, which interferes with an obvious natural differentiation in the meaning of the short and long forms, clearly seen in the difference already acquired between such words as *historic* and *historical*, *politic* and *political*, *microscopic* and *microscopical* (what, for example, would a microscopic society be?).

The natural impulse is to ignore the deficiencies that one sees in a work of this nature and take up the enumeration of the many sterling qualities that it so manifestly possesses, but aside from the fact that this would be quite useless to the reader, since

he will see them for himself, one is here confronted with so many actual difficulties in the way of the comprehension of the scheme that it seems necessary to devote whatever space may be left after this attempt at exposition to the consideration of a few at least of these difficulties. There is certainly one salient feature of the work that demands a passing notice. It claims to be 'the Philosophy of Science,' as opposed to 'Idealism,' on the one hand, and 'Materialism,' on the other, and a large part of it is devoted to soundly belaboring both these spurious systems, but especially what the author calls *metaphysics*, which rests upon idealism. The arch-enemy of Truth and chief source of Error is the philosophy which reduces the universe to a subjective state of the thinking or knowing mind. What is elsewhere called 'epistemology,' and is defined as 'the theory of knowledge,' proves uniformly to be a theory of no-knowledge, or a proof that the mind can know nothing but its own states. Major Powell calls this book a treatise on epistemology (which is always written 'epistomology,' as if it had to do with the digestive rather than the cogitative apparatus). But, unlike the current epistemology, its aim is to show that there is an objective, knowable world, the world with which science so effectively deals. All this is well, and no scientific man can object to it. But how does he succeed in this? When, as at the threshold, he approaches the nature of matter he is baffled as completely as the school boy, or as the other savants who have grappled with this problem. He seems to think, however, that he has found a way out of the difficulty. Between the thesis and the antithesis of the second Kantian antinomy he thinks he has found a Hegelian synthesis. This compromise or reconciliation consists in maintaining, as the term implies, that the five 'constituents' constitute matter. These constituents, as

we have seen, are number, space, motion, time and judgment. They must all exist in every particle, but besides and beyond them there is nothing. They *are* matter. Sometimes (*e. g.*, on p. 119) he calls these the 'properties of matter.' At other times he seems to talk as though it were rather the five 'essentials' or 'manifestations' (unity, extension, speed, persistence, consciousness) that really 'constitute the particle' (p. 183). But at any rate there is nothing but these properties or manifestations, and when he speaks of 'substrates' he calls the essentials the substrates of the corresponding variables (plurality, position, path, change, choice), and does not mean any real substrate of which any one or all of these attributes can be predicated. Now, to the ordinary mind, or naïve intellect, such things as space, time, motion, or as extension and speed (rate of motion), seem to be wholly immaterial. Some of them, as space and time, are mere conditions under which things exist. Motion we must agree with him in regarding as a state in which all matter always exists. Extension is a property that matter *possesses*. But when Major Powell refers to space he says he does not mean 'void space,' which he says is a pseud-idea. Yet most persons can clearly conceive of void space. He must refer to the matter that is in space. This is simply a question of language. When he speaks of time he says he does not mean 'void time, but the time of states and events' (p. 253). But any one can 'think away' the whole universe of matter and both space and time will remain. He says there is no such thing as void space, and many passages indicate that he accepts the *plenum*. Although this is inconsistent with motion, and even with number, except unity, it will seem to many that if matter is made up of such intangible constituents as space, time, extension, speed, and judgment it makes very little difference whether the

universe is *full* of them or not. Like the deathless Shades of Walhalla, hack and hew them as you may, they will instantly regain their forms and return to the combat.

By thus constructing the material universe out of five immaterial elements Major Powell seems to think that he has made his peace with the idealists and won the right to turn upon the materialists. It cannot be denied that he has evolved a system as thoroughly ideal as that of Berkeley, and about the only difference between it and the Berkeleyan idealism is that it consists of five nothings instead of one. For the last of the Powellian nothings, judgment, consciousness, etc., is the whole of the Berkeleyan nothing, mind, and the Hegelian *Nichts*, thought. But are not consciousness, mind, thought, real things and important things? Undoubtedly, and so are justice, honor, truth, freedom, yet no one thinks of making these the constituents of matter and the contents of the material universe. All these numberless terms of elevated and refined thought and sentiment stand for *relations* subsisting among material things, but which are themselves necessarily immaterial, as much so as distance or direction. The number and kinds of relations are innumerable. By a little convenient expansion the term may be made to include space, time, motion, extension, velocity, persistence, resistance, judgment, consciousness, feeling, thought, mind, love, sympathy, virtue, justice, truth, liberty, peace, ambition, character—all the higher and more evolved conceptions of intellectual and emotional beings. But if any one prefers to call them properties, attributes, or even qualities, there need be no objection; they may be any of these things, but they are not matter nor the constituents of matter. Major Powell says that the metaphysicians 'reify' mere properties or attributes. He has reified abstract relations and constructed a phantom world out of nothing.

There is one other favorite idea in this book which it is difficult to resist touching upon, however lightly. It is the doctrine of *hylozoism*, which the author approaches at first haltingly and doubtingly, but which before the close assumes the form of a full-fledged dogma without the acceptance of which it is almost admitted the whole structure falls to the ground. Really there was no occasion for the initial timidity, as the doctrine is backed up by a long line of the best thinkers of all ages. In fact, it is one of those conceptions which cannot be escaped by the mind if only it goes on to the logical term in its reasoning, and it has never been gainsaid in any legitimate argumentation. There need, therefore, be no quarrel as to the notion itself that the highest attribute of nature, call it mind, soul, spirit, thought, or what you may, resides also in the lowest and simplest form of existence. No true philosopher will or can deny this proposition. The 'fallacies,' to use Major Powell's regular word for the errors of human reasoning, all occur in the mode of approaching this great truth. It is so in the present case. His fallacy lurks at the outset in the fifth and last term of the first three or four series of cosmic principles—in the terms judgment, consciousness, concept, choice, etc.—terms which connote psychic processes not introduced in the course of evolution until the cosmic stage had been passed and the organic stage had been ushered in. The fallacy is most manifest in the discussion of the terms 'affinity' and 'choice.' Here our author becomes thoroughly metaphysical. On pages 40 and 41 he says: "We have now discovered that there is an additional property of the inanimate particle when it is incorporated, and that this is affinity. All we know of affinity is that it is the choice of one particle for another as its associate or as their mutual choice. Here we are introduced to the multitudinous phenomena of affinity which

can be explained only as choice." On pages 188 and 189 he further says: "The primal law of evolution seems to be psychic. We shall call it the law of affinity and define it as choice of particles to associate in bodies." Finally, on page 267, he asserts that "the ultimate particles of inanimate bodies have self-activity in so far as they manifest choice or affinity." Now this is not 'reification,' which belongs to the metaphysical stage of thought in Comte's celebrated *trois états*; it is 'imputation,' which belongs to the first or fetishistic phase of the theological stage, which, as Major Powell has elsewhere so ably shown, characterizes the thinking of the primordial savage. To the glorious company of Chuar, Spencer and Hegel, Powell must surely be added!

The whole idea of choice or affinity is anthropomorphic. It is to be compared with the popular idea of attraction, or gravitation as produced by one body drawing another through void space; an idea, by the way, which Major Powell justly assails as essentially metaphysical, involving the *actio in distans*, and demanding a belief in some sort of magic. There is no difference between the attraction of bodies and the affinities of atoms, so far as this principle is concerned. To call it 'psychic' is an anachronism. To say that the action of a magnet or an attracting body, or the behavior of chemical substances toward one another, is judgment, or consciousness, or choice, except metaphorically, is to ignore the vast series of steps in evolution which separate the chemical atom from protoplasm and span the chasm between the inorganic and the organic worlds. Hylozoism simply asserts that the elements and raw materials are there, even at the bottom of the scale, but it does not say that a bank of clay is a house of brick, or that a block of marble is a Venus of Milo. The worst feature of this doctrine, which pervades the work and

affects the whole scheme, is that it is quite unnecessary and superfluous. If, as the law of the conservation of energy demonstrates, all matter exists in a state of motion which is as unchangeable and indestructible as matter itself, is its one essential attribute, what more is required? Is not this the true 'self-activity,' the true hylozoism? Everything else follows from this. Every higher manifestation is the result of aggregation, of compounding and re-compounding—in a word, of organization, first chemical, then biotic, then psychic. All differences are differences of degree, and the universe is one.

The last question to be asked is: Why pentalogic? Is the universe really a quincunx? Or has it been forced to take this form? We all know how strong the love of symmetry is in man, and too great symmetry in a treatise claiming to be scientific stamps it as artificial if nothing more. It has been said that nature makes only individuals and man make species, genera, families. The real world will not fit into our square or round or oval frames. The mind strains to make it fit. The search for analogies has been universal. The old cosmologies largely go by numbers—by threes, or fours, or fives, or sevens, or twelves. Reasons for this are always at hand—the number of fates, of points to the compass, of fingers on the hand, of days in the week, of tribes of Israel, of apostles, etc. There has never been any difficulty in making a philosophical system conform to any of these charmed numbers. Instead, therefore, of strengthening his argument by referring (p. 112) to the well-known origin of the decimal system in the number of digits, and declaring that 'the universe is pentalogic,' Major Powell has thereby greatly weakened it by an analogy devoid of the least causal connection. Every biologist knows that it was an accident that in the phylogenetic development of the

higher animals, from the many-boned fins of fishes through the multidigitate *Dipneusta* to the five-toed Batrachians, the reduction of digits happened to be arrested at this stage. Really, though, it never was arrested, but went on through the cloven-footed ungulates, until in the horse the number was reduced to one; so that the horse is the most highly developed animal, as Professor Cope and Dean Swift agreed in asserting. But this theological argument is further demolished by the superiority of other than pentalogic systems, the duodecimal, and especially the octonal. If four instead of five had been the magic number no one can calculate the economy it would have wrought in human affairs.

The direct study of nature reveals everywhere irregularity, heterogeneity, amorphism, chaos; and however laudable the effort to reduce this anarchy to law and this chaos to cosmos, any attempt in this direction which goes beyond the limit set by concrete facts is, by minds trained to the scientific habit, dismissed at once as not science, whatever else it may be.

It seems a pity that a book which is obviously the product of such prolonged and profound philosophical meditation by a mind so well stored with scientific knowledge and direct experience with the real world should be handicapped in the manner here pointed out. The above specifications in this regard are not meant for criticisms. They are made rather to prepare the reader for what he may expect in the hope that he may ignore them as far as possible and persevere to the end, assuring him that, read in the right spirit, this book will furnish food for reflection and new views of science and philosophy. Meanwhile we commend to the author the two following passages from his book:

"For some purposes of discussion a schematization may be of more or less value, but it easily degenerates into illogical

classification, especially when it becomes the foundation of a philosophy." (Pp. 119-120.)

"The true method of classification is not by invention, but by discovery." (P. 113.)

LESTER F. WARD.

INCONSIDERATE LEGISLATION ON BIRDS.

THE following bill has passed the House, and, as amended by Senator Hoar, has met with the approval of the Senate. If the amended bill meets with the approval of the House Conferees it will probably become a law :

An Act to Extend the Powers and Duties of the Commission of Fish and Fisheries to Include Game Birds and Other Wild Birds Useful to Man :

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, that the United States Commission of Fish and Fisheries shall hereafter be known and designated as the United States Commission of Fish, Fisheries and Birds. The duties and powers of said commission are hereby enlarged so as to include the propagation, distribution, transportation, introduction and restoration of game birds and other wild birds useful to man. For such purposes they may purchase, or cause to be captured, such game birds and other wild birds as they may require therefor, subject, however, to the laws of the various States and Territories in which they may conduct such operations.

The object and purpose of this Act is to aid in the restoration of such birds in those parts of the United States adapted thereto where the same have become scarce or extinct, and also to aid in the introduction of new and valuable varieties or species of American or foreign birds in localities where they have not heretofore existed.

Said Commission shall from time to time collect and publish useful information as to the propagation, uses and preservation of such birds.

And the said Commission shall make and publish all needful rules and regulations for

carrying out the purposes of this Act, and shall expend for said purposes such sums as Congress may appropriate therefor.

The Amendments are as follows :

That the importation into the United States of birds, feathers or parts of birds for ornamental purposes be and the same is hereby prohibited : *Provided, however,* That nothing herein contained shall be construed as prohibiting the importation of birds for museums, zoological gardens, or scientific collections, or the importation of living birds or of feathers taken from living birds without injury to the bird. The Secretary of the Treasury is hereby authorized to make regulations for carrying into effect the provisions of this section.

That the transportation of birds, feathers or parts of birds, to be used or sold from any State or Territory of the United States is hereby prohibited. Whoever shall violate the provisions of this section shall, upon conviction in the district where the offense shall have been committed, be punished for each such offense by a fine of \$50.

That the sale, keeping or offering for sale, within any Territory of the United States, or within the District of Columbia, of birds, feathers or parts of birds for ornamental purposes, except such as are excepted in the first section of this Act, be and the same is hereby prohibited. Whoever shall violate the provisions of this section shall, upon conviction, be punished for such offense by a fine of \$50.

In view of the high grade of ornithological work which the Department of Agriculture has already performed, and of the eminently scientific character of its personnel, it seems a great pity that work so clearly of an agricultural nature should be given to the Fish Commission, a department which has neither the experiment stations, the men nor the means to effectively undertake such duties, and whose hatcheries are in localities so remote from sources of supply that the work can only be done, if at all, at a great sacrifice of time, money and energy.

The introduction of new species into a country is, in any case, a dangerous ex-

periment—as witness the English Sparrow—and if undertaken at all should be done only under that branch of the government service which for many years has been charged by Congress with investigations of the economic status of birds and mammals. While we should gladly see feathers and parts of birds obtained by killing the birds no longer used for ornamental purposes, it is probable that legislation would accomplish nothing. On the whole, the bill appears useless, and the new functions given to the Fish Commission are extremely ill-advised. Such bills should be referred to a committee of the National Academy of Sciences for an opinion.

ELEVENTH ANNUAL MEETING OF THE GEOLOGICAL SOCIETY OF AMERICA, DECEMBER 28TH, 29TH AND 30TH, NEW YORK.

II.

Origin of the Grahamite in Ritchie Co., W. Va. I. C. WHITE, Morgantown, W. Va.

THIS mineral, resembling coal in physical aspect, and extending, in a vertical fissure two to three feet wide, downward to an unknown depth, was shown to be a residual product derived from the evaporation of petroleum. Its location is near the 'Oil-break' anticline of Andrews, and it probably tapped off oil from the 'Saltwater Sandstone' of the drillers. This sandstone is now the source of productive wells located near the Grahamite vein.

The paper led to the discussion of asphaltic deposits in fissures and to the source of graphite and other hydro-carbons in pegmatite veins. A. P. Coleman cited the anthraxolite of the Sudbury region, an ultra-anthracitic material in fissures. J. S. Diller mentioned the pitch-coal of the Coos Bay lignite mines, Oregon, which cuts the lignite in veins. J. F. Kemp brought up the graphitic pegmatites of the Adirondacks, the presence of small amounts of carbon in

the gabbros and the tarry material in the Branchville, Conn., quartz. M. E. Wadsworth referred to carbon in meteorites.

Structure of the Iola Gas Field, Allen Co., Kansas. EDWARD ORTON, Columbus, O.
Read by I. C. White, in the absence of the author.

NATURAL gas is more widely distributed, geologically and geographically, and exists in larger quantity than any one would have claimed 20 or even 10 years ago. Its productive horizons cover the entire Paleozoic column of the country. Cities supplied, at least partially, with natural gas for fuel and light are no longer uncommon. Two distinct divisions can be made of its accumulations, viz.: That which is stored in impervious rocks as shales, most limestones, etc., and that which is found in porous rocks. These divisions may be provisionally styled *Shale gas* and *Reservoir gas*, each having characteristics of its own. *Shale gas* occurs in comparatively small wells. Its wells lack uniformity of rock pressure. It does not occupy definite horizons; it exists independently of petroleum in many cases, has *staying* properties, does not depend on the structural arrangement of the strata that contain it. *Reservoir gas* is found in great wells, approaches uniformity of rock pressure in each subdivision of territory, occupies definite horizons, is accompanied by oil, its wells generally come to a sudden end, is entirely controlled by the structure of the rocks in which it is accumulated. Two structural phases of rocks are specially important in this connection, the *anticline* and the *terrace*. The time has come for the acknowledgment of *structure* in reservoir gas fields even in advance of measurements. The Iola gas field is one of great promise. Its source is in a sandstone of the Cherokee shales, or near the bottom of the coal measures. It proves to be a *terrace* of well-marked character. For seven miles the top of the

gas rock has an elevation of 131 feet above tide, rising at no point more than 45 feet above this. At this summit the largest well of the field is located. The relations were shown by a geological cross-section. The importance of the fuel to the local zinc industry was described.

There was no important discussion.

The Conshohocken Plastic Clays. T. C. HOPKINS, State College, Pa.

THE plastic clays near Conshohocken, Pa., form an isolated deposit. The resemblances to the New Jersey and Gay Head clays in colors, texture and structural features suggest clays of the same age. The location and character of the deposits were briefly described. There was no discussion.

A Remarkable Landslip on the Rivière Blanche, Portneuf County, Quebec. GEORGE M. DAWSON, Ottawa, Ont.

In this paper a brief account was given of the landslip that occurred on May 7th, last. It affected the thick deposit of Leda clay that floors this part of the St. Lawrence plain and serves to indicate that a clay of this character may, under certain circumstances, for a short time, behave almost as a liquid. The paper was illustrated by the lantern and threw light on disturbed glacial or post-glacial deposits elsewhere.

Ripple-Marks and Cross-Bedding. G. K. GILBERT, Washington, D. C.

THE general theory of ripple-marks, as developed by Darwin and others, was outlined and the relation of ripple-mark dimensions to dimensions of water oscillation was set forth. In general the distance between the crests of the ripple-marks is half the height of the wave that causes them. At the surface the particles sharing in the wave describe circles. In depths the circles flatten to ellipses and at last to forward and backward oscillations, which develop the ripple-marks. Giant ripple-marks of Me-

dina sandstones were described, with crests up to 30 feet apart. The physical conditions in which they were developed were inferred, and waves up to 60 feet high were indicated. When ordinary wind waves are complicated by currents, compound and complex cross-bedding is caused by deposition on rippled surface. The tops of the ripple-marks are cut off and deposited on the flanks of the ridges and lead to cross-bedding of variable dip and strike, which in this way differs from the cross-bedding of deltas and currents. The paper was illustrated by the lantern.

Volcanoes of Southeastern Russia. HARRY FIELDING REID, Baltimore, Md.

DURING the Russian excursion of 1897 the author visited the three very high volcanic mountains, Elbruz and Kazbek, in the Caucasus, and Ararat, farther south. This paper gives a brief description of these mountains and was illustrated by lantern views. The physiography of the region traversed, its lake basins and glaciers were all described. Special attention was given to Mt. Ararat. The supposed thawing of its snow fields by the heat developed from oxidizing pyrites was set before the Society and discussion asked, and the question of the abundance of fulgurites on one peak of Ararat and their scarcity elsewhere was proposed to the Society for explanation.

L. V. Pirsson and others dismissed the pyrites as a source of heat on account of its manifest and absurd inefficiency, despite the fact that it had been seriously advanced abroad. Experience in the Sierras led C. D. Walcott to attribute the absence of snow in certain spots to the action of wind. E. O. Hovey spoke of the occurrence of the fulgurites on Little Ararat, and A. Heilprin remarked their independence of the kind of rock and cited the unusually large ones he had met in the desert of Sahara. He also spoke of the similarity of the profile of

Ararat to that of Shasta, and others said the same of Shishaldin.

The Society then adjourned for lunch.

PETROGRAPHIC SECTION.

On reassembling for the afternoon session the Society divided into two sections, in order to finish the program. The petrographic section listened to the following papers:

Differences in Batholithic Granites According to Depth of Erosion. B. K. EMERSON, Amherst, Mass.

THE speaker reviewed the distribution of granitic rocks in Massachusetts, illustrating his remarks with a sketch map of it and of the neighboring States to the south. He commented on the tonalite near Northampton, the Cape Ann area, the Quincy area and the extension of quartz porphyries and felsites to the southwest of the last. He outlined another belt of igneous rocks that passes near Worcester. He then developed the idea regarding the tonalite that it had fused its way upward, involving in itself the overlying schists to such a degree that zones can be traced around the granite proper that mark the various stages of absorption or metamorphism of the schists. From the granite outward there is a fibrolitic zone, then a chiasolitic, next an andalusitic and lastly the schists. Given one of these zones, such as the chiasolitic at Lancaster, the presence of the granite may be confidently predicted in depth, although not actually visible. The demarcation of the zones is sharp enough to admit of mapping.

The next two papers followed before discussion.

Metamorphosed. Basic Dikes in the Manhattan Schists, New York City. J. F. KEMP, New York City.

HORNBLÉNDE schists in narrow belts have long been known in the prevailing mica-schists of Manhattan Island. This paper

describes one special occurrence on Morningside Park, between 118th and 119th Streets, near the Columbia University Campus. A small detailed map was shown, together with analyses and petrographic details of the amphibolite and of the mica-schists. The speaker stated that the amphibolite must be referred to an igneous intrusion or to limey bands in the schists. The most reasonable interpretation seemed to him to be the igneous. The rocks were illustrated by projecting thin sections with a polarizing microscopic lantern.

The Granites on the North Shore of Long Island Sound, with some Observations on the Granites of the Atlantic Coast in General. J. F. KEMP, New York City.

THE general character of the crystalline rocks along the sound from New Haven to Narragansett Bay was outlined, and it was shown that they are chiefly granitic gneisses, with pronounced foliation, but with some augen-gneiss and considerable basic hornblendic and biotitic schist. The granites at Niantic and Westerly, R. I., and at New London, Millstone Point, Stony Creek and some minor localities in Connecticut were discussed. They were shown to be biotite-granites of several varieties. Although they have nearly or quite the same mineralogy as the prevailing gneiss of the region, their intrusive character was shown by their relations to the wall-rocks and by their peculiar inclusions of the basic hornblendic and biotitic schists. The supposed Carboniferous age of the Connecticut granite, as advanced by Pirsson, was mentioned as perhaps indicating a fairly late age for those in the gneissic areas. Slides of the rocks discussed were afterwards thrown on the screen with the polarizing microscope. The remarkable development of pegmatites that everywhere characterize the region was also discussed, both as regards mineralogy and geological relations. They vary from coarse

aggregates of pink microcline, natron-orthoclase, quartz, biotite and ilmenite to practically pure quartz, intermediate varieties being present. The paper concluded with a general review of the granites of the Atlantic sea-board and stated that they are with few exceptions biotite granites. Such analyses as are available were used in illustration.

In discussion of the last three papers M. E. Wadsworth remarked with regard to the amphibolites of the second paper the similar changes in peridotite dikes on Lake Superior and their clear igneous character. In reply J. F. Kemp mentioned the serpentines near New York, which have lately been shown by D. H. Newland to contain recognizable olivine, and which are probably altered basic, igneous rocks. Whitman Cross stated that the Colorado granites with which he was familiar had sharp contacts with the wall rocks and showed no such infusion as described by Professor Emerson. They resembled rather the granites of the Long Island Sound region. M. E. Wadsworth remarked that he had always been able to find evidence of the intrusive nature of massive granites wherever he had searched for it and he controverted the idea that metamorphism was responsible for them. Referring to the supposed post-Carboniferous age of the Conanicut granite J. E. Wolff stated that he and his associates at Cambridge had reached the conclusion that the granite intruded Cambrian and not Carboniferous strata. In reply to the remarks of Whitman Cross, B. K. Emerson again reviewed his interpretation of the Massachusetts phenomena.

Augite-syenite near Loon Lake, N. Y. H. P. CUSHING, Cleveland, O.

AN interesting section exposed in a railroad cut near Loon Lake shows an intrusive rock which has caught up fragments of the Grenville series. The rock is related

to the augite-syenites but the chemical analysis shows some unusual features. A large area of anorthosite mapped in Franklin county, N. Y., the past summer, was found to grade into similar rocks on all sides, and they are, therefore, regarded as variants of the gabbro magma. They present a range from rocks of the acidity of granite to basic gabbros. The analysis quoted was by E. W. Morley and was as follows:

SiO₂, 63.45, TiO₂, 0.07, Al₂O₃, 18.31, Fe₂O₃, 0.42, FeO 3.56, MnO none, CaO 2.93, BaO 0.13, MgO 0.35, K₂O 5.15, Na₂O 5.06. Loss, 0.30. Total, 99.73. The rock is composed of microperthite, quartz, hypersthene, a pyroxene near diallage and a little plagioclase. It was compared with Cape Ann and Norwegian relatives.

In discussion J. F. Kemp remarked the presence of related rocks in the Adirondack region south of Professor Cushing's area and the possibility of others having been pinched into the gneisses and disguised by metamorphism. H. S. Washington emphasized their close parallelism with the Cape Ann varieties described by him. M. E. Wadsworth discussed the passage of Minnesota gabbros into rocks of this type, and N. H. Winchell gave a most interesting review of recent results in the study of the Minnesota gabbros and their relatives. Beginning with anorthosites he showed their passage into gabbros and their occurrence both as inclusions and as segregations in diabases. The gabbros grade into the 'muscovadites' of the Minnesota geologists and the muscovadites into greenstones and perhaps into jaspilite and iron ore. R. A. Daly remarked the presence of the same rocks as those described by Cushing in Mt. Ascutney, Vt., and quoted an analysis that was very much like Cushing's. He outlined the curious change in color that the rock undergoes when quarried. He stated that it also occurs at Cuttingsville in the Killingly Peaks, Vt.

On the Phenocrysts of Intrusive Igneous Rocks.

L. V. PIRSSON, New Haven, Conn.

THE speaker argued for the formation of phenocrysts at or near the places where they are found in rocks, and against the necessity of the generally accepted idea that they are deep-seated and older crystallizations brought up by the magma, *i. e.*, against the necessary 'intratelluric' nature of them. He distinguished the 'single' type which does not occur as a mineral of the ground mass and the 'recurrent' type which does. As incompatible with an intratelluric origin, he advanced the following well-known phenomena: (1) Absence of phenocrysts from contact zones. (2) Absence from dikes and sheets whose parent laccolite is richly provided with them. (3) The throngs of small rod-like crystals that surround phenocrysts and are not flow-phenomena, but due to crowding back, by growth of phenocrysts; further tabular phenocrysts which occur in all orientations in a rock. (4) Phenocrysts of porphyritic granites may or may not be intratelluric, according as we view porphyritic rocks as differing from granitoid in kind or in degree. (5) Micro-structure, both internal as regards inclusions and external as regards surrounding crystals, may be explained by formation near the surface. The arguments for an intratelluric origin, *viz.*: (1) Large size, and (2) flow-arrangement and resorption-phenomena, were discussed. As opposed to the views of the French petrographers, that there are two distinct periods in the crystallization of every igneous rock, and of the Germans, that there are two for the porphyritic and one for the granitoid, Pirsson argued for only one for each, and emphasized the viscosity of the magma as an important factor in conditioning the epoch of crystallization, and the rate of cooling as of great influence on the result. With a long time, *i. e.*, slow cooling, the granitoid texture results; with

a short period, the porphyritic or felsitic. The presence of water-vapor is also important. With a quick fall in temperature the earliest minerals to begin have the best chance to develop; the later ones are hurried or are cut off. Hence, single phenocrysts result. Mass action is also important. The most abundant minerals have a predominant tendency to develop. Too great regularity is not, however, to be expected in Nature. The speaker closed with a statement that he had no hopes of the Section agreeing with him, but he courted discussion. He was mildly thunder-struck to find very general agreement and approval as evinced in remarks by J. P. Iddings and Whitman Cross, although, the hour being late, the paper could not receive the attention that its importance and interest merited.

The last paper of the Section was the following:

The Mica Deposits of the United States. J. A. HOLMES, Chapel Hill, N. C.

THE speaker stated that to-day all the commercial mica produced in the United States is derived from North Carolina. It is universally obtained from pegmatite dikes, in which as a maximum not over 1 or 1½ per cent. of the dike is mica, and about 0.1 per cent. is the rule. About 5 per cent. of this mica or less is merchantable as sheets; the rest, if utilized, is ground. The chief defects are the crushing and warping due to dynamic processes, and the so-called 'ruling' or cleavage which runs across the leaves and is probably due to pressure. The speaker described in particular the mica deposits of New Mexico, where the pegmatites are associated with granites at the base of the Grand Cañon series and are older than the Algonkian. They are damaged by folding and pressure, which, however, largely fail in the Appalachian belt. The hour being late, no discussion followed, and after a vote of thanks to the authori-

ties of Columbia University the section adjourned.

GENERAL SECTION.

In the other section, before which papers bearing on glacial geology and some more general topics were read, the following program was presented. The notes of the section on which the following account is chiefly based were kept by Arthur Hollick, but by a misunderstanding they are less complete than those for the previous papers:

Pre-Cambrian Fossiliferous Formations. CHAS. D. WALCOTT, Washington, D. C.

A DESCRIPTION was given of the pre-Cambrian formations which have yielded traces of life, including the announcement of the discovery of fossils indicating highly organized life in the pre-Cambrian belt terrane of Montana. The fossils occur in a fissile black shale or slate called the Empire shales and are of eurypteroid forms. The paper was illustrated by geological sections and by photographs and specimens of the fossils. It was discussed by J. A. Holmes, H. S. Williams, Bailey Willis and H. M. Ami.

After the reading of the paper opportunity was given for the discussion of the papers presented the day before by W. D. Johnson and H. W. Turner. The discussion was participated in by I. C. Russell, H. F. Reid, G. K. Gilbert and W. D. Johnson.

Ice Sculpture in Western New York. G. K. GILBERT, Washington, D. C.

CAREFUL study of the Niagara escarpment in Niagara county shows that its greater features are pre-glacial, but glacial erosion has wrought important modification. The Medina shale has been so deeply sculptured as to obliterate its pre-glacial relief and substitute a broad fluting in the direction of ice movement. At Thirty Mile Point a mass of strata several hundred feet broad has been moved by the ice. The paper

was illustrated by charts and was discussed H. F. Reid and Robert Bell.

The Wind Deposits of Eastern Minnesota. C. W. HALL and F. W. SARDESON, Minneapolis, Minn.

THE paper treated of the character, origin and age of the lag gravels and dune sands so frequently seen in eastern Minnesota—more particularly in the district between the Mississippi and St. Croix Rivers. These deposits in the vicinity of Minneapolis have been more particularly studied and their relations to some fossiliferous post-glacial water deposits were considered. The paper was illustrated by photographs and was discussed by Arthur Hollick and J. B. Woodworth.

The Iroquois Beach at Toronto and its Fossils. A. P. COLEMAN, Toronto, Canada.

THE Iroquois beach north of Lake Ontario was long ago mapped in outline by Spencer, but many details in this shoreline remain to be filled in. Near Toronto two bays are found, one near Carlton on the west, the other near York on the east. Each has an area of several square miles and is cut off from the main lake by a gravel bar like the present Toronto Island. Horns of caribou are common in the Carlton bar, and teeth of the mammoth have been found in the bar near York. Fresh-water shells of four species—*Campeloma decisa* the most common—are found in beach gravels of Iroquois age near Reservoir Park, Toronto. These are the fresh-water fossils found without doubt in the Iroquois beach deposits. As the main Pleistocene beaches from Agassiz to Iroquois contain fresh-water shells, they must have been formed in lakes and not arms of the sea. The numerous marine shell-bearing deposits of the east of Canada cease before Lake Ontario is reached. The paper was illustrated by diagrams and by fossil shells.

It was discussed by G. K. Gilbert, Robert Bell and J. B. Woodworth.

Thames River Terraces. F. P. GULLIVER, Southboro', Mass.

Cuts have recently been made for a new line of railway on the east bank of the Thames river between New London and Norwich. They expose the structure of many terraces which were regarded as Champlain deposits by the late Professor J. D. Dana, and which were referred to the post-glacial, flooded rivers. The presence of eskers at lower levels has, however, always been a fact difficult of explanation on this hypothesis. The railway cuts expose many delta lobes of fine sand which point down stream and toward the sides of the old valley and rest upon its covering of till. In instances their axes point up side valleys and away from the central axis of the main valley. The fine sand is covered by coarse boulders, such as are found in front of Alaska glaciers. The speaker explained them as due to a retreating glacier which filled the center of the main valley and discharged its waters and sediment laterally as well as longitudinally. This raised the question of possible side-ponds to the glacier, at one or several altitudes and of the corresponding new interpretation of the terraces that would follow as a result of the suggestion.

The Gold-bearing Veins of Bag Bay, Western Ontario. PETER McKELLAR, Fort William, Ont.

THE object of this paper is to show the peculiarities of the gold-bearing veins in the granite area at Bag Bay, Shoal Lake, west of the Lake of the Woods, Ontario. These veins are characterized by the smallness of the quartz fissures compared with the quantity of valuable ore they yield under development. The paper was read by Robert Bell in the absence of the author. At its conclusion the following were read by title:

Stratigraphy of the Pottsville Series in Kentucky.

MARIUS R. CAMPBELL, Washington, D. C.

American Homotaxial Equivalents of the Original Permian. CHARLES R. KEYES, Des Moines, Iowa.

Geology and Physiography of the West Indies. ROBERT T. HILL, Washington, D. C.

Surface Features of Northern Kentucky. MARIUS R. CAMPBELL, Washington, D. C.

Conditions of Formation of Dykes and Vein Fissures. N. S. SHALER, Cambridge, Mass.

Geology of the Crystalline Rocks of Manhattan Island and Vicinity. FREDERICK J. H. MERRILL, Albany, N. Y.

Origin of the Highland Gorge of the Hudson River. FREDERICK J. H. MERRILL, Albany, N. Y.

The Iowan Drift. SAMUEL CALVIN, Iowa City, Iowa.

Loess Deposits of Montana. N. S. SHALER, Cambridge, Mass.

Spacing of Rivers with Reference to the Hypothesis of Baseleveling. N. S. SHALER, Cambridge, Mass.

Glacial Phenomena of the Yukon Valley. J. B. TYRRELL, Ottawa, Canada.

The section then adjourned, after a vote of thanks to the authorities of Columbia University.

The meeting proved a very successful one, 75 Fellows of the 230 of the Society being present.

The following officers were announced as elected for the ensuing year: President, B. K. Emerson, of Amherst College; First Vice-President, G. M. Dawson, Canadian Geological Survey; Second Vice-President, C. D. Walcott, United States Geological Survey; Secretary, H. L. Fairchild, Rochester University; Treasurer, I. C. White, West Virginia Geological Survey; Editor, J. Stanley Brown, Washington, D. C.; Librarian, H. P. Cushing, Western Reserve University; Councillors, J. S. Diller, J. M. Safford, W.

B. Scott, M. E. Wadsworth, W. S. Davis, J. A. Holmes.

The following nominees were elected Fellows: A. R. Crook, Evanston, Ill.; N. F. Drake, Tientsin, China; A. H. Elftman, Grand Marais, Minn.; M. L. Fuller, Boston, Mass.; A. W. Grabau, Cambridge, Mass.; J. H. Pratt, Chapel Hill, N. C.; F. C. Smith, Deadwood, S. D.; F. B. Van Horn, Cleveland, Ohio; T. G. White, New York; S. W. Williston, Lawrence, Kansas.

J. F. KEMP.

COLUMBIA UNIVERSITY.

WINTER MEETING OF THE ANTHROPOLOGICAL SECTION OF THE AMERICAN ASSOCIATION.

THE third winter meeting of the Anthropological Section of the American Association for the Advancement of Science was held in New York on December 27th and 28th. The sessions, which were three in number, and were immediately followed by the meeting of the American Folk-lore Society, took place in the buildings of Columbia University. The attendance was materially greater than at Ithaca last winter, and in general the meeting was successful and enjoyable. The chairman, Professor Cattell, presided, and Dr. M. H. Saville was Secretary.

Eleven papers were presented, two read in abstract, and several read by title. A commendable feature of the program was its grouping of related papers. Thus the first session was devoted to physical anthropology, the second to archæology and the third was generally ethnological. It was found impracticable to follow this scheme rigidly, but it was observed sufficiently to give the discussions more distinct tendencies and greater coherence.

The first paper read—one of more than ordinary value and interest on account of its dealing with aims and methods rather than material—was by Dr. Franz Boas, and was

entitled 'Some Recent Criticisms of Physical Anthropology.' The first objection considered was the assertion that any classification of mankind by physical anthropology must be valueless because it has been found impossible to identify positively an individual, at least from his skeleton, as belonging to a group. The answer to this criticism was found in the fact that the physical anthropologist studies not individuals, but geographical or social groups. He does not concern himself with assigning individuals to groups, but with marking the differences and relationships of groups as such. That is to say, physical anthropology deals with types, not persons, and the types can be clearly distinguished and classified. Of course, the significance of the type or group depends largely on its stability, and whether there is such stability depends upon the question whether heredity or environment influences anatomical changes to a greater degree, and this question can be finally solved only by an exhaustive statistical study of several generations. Meanwhile, however, heredity would seem to be the more potent, as various evidence instanced appears to show. Hence it is concluded that the types studied by the physical anthropologist are permanent and not fortuitous or meaningless, and, therefore, allow of classification. The rest of the paper was devoted to a consideration of objections to the metrical method. The values of this method, especially in giving information obtainable in no other way, were insisted upon. But the necessity of all measurements made having some biological significance was strenuously urged. Especially useless, even harmful, were sweeping classifications by merely one arbitrarily-chosen measurement, such as those based upon the cephalic index alone.

Dr. Ales Hrdlicka followed with a paper upon the 'Negro Problem.' Dr. Hrdlicka analyzed and refuted the common belief

that, relatively to the white, the negro is decreasing. The greater increase among whites is due in large part to immigration. Without this factor, which has generally been overlooked, white increase is smaller than negro. This is borne out by the higher birth-rate among negroes. The present compensation of a higher infant mortality will tend to disappear as the negro is raised. Consequently we shall soon be confronted with the circumstance of an ever greater proportion of negro population. The author reviewed various methods of dealing with the negro problem, finally advocating that of dispersion.

Dr. Thomas Wilson presented a paper upon modes of lighting museums, embodying the results of investigations made by him upon the transparency of kinds of glass, illustrated by photographs. A paper by Mr. Roland B. Dixon upon 'Color Symbolism of the Cardinal Points' concluded the morning's session. The paper was devoted largely to a discussion of the various bases of association of colors with directions, such as light, climate, geographical position, religion; with the conclusion, reached also in the ensuing discussion, that there is no such principle of association that is universal.

The afternoon session was devoted to archæology, and it is perhaps a significant fact that all the papers dealt with the extreme western portion of the continent. Dr. M. H. Saville presented a brief paper upon the 'Mexican Stone Yoke,' which he concluded to be a symbol of death. The other papers on the program were: 'Contents of a Room Excavated in the Ruins of Pueblo Bonito, showing a Specialized Form of Pottery,' by Mr. J. H. Pepper; 'Archæological Investigations on the North Pacific Coast of America,' by Mr. H. I. Smith; 'The California Indians,' by Professor McGee; and 'Archæological Problems of California,' by Professor Holmes, the last

mentioned being postponed to the following session. Professor McGee's extremely interesting paper opened a discussion as to the causes of the linguistic diversity of certain regions, such as California; and Professor Holmes demonstrated very clearly the great improbability of the remains in California auriferous gravels, including the Calaveras skull, dating back, as has been claimed, to Middle Tertiary times. Owing to the specialized and generally miscellaneous character of all these papers, it is impossible even to attempt a summary of them. But one point which they all made and emphasized in common seems to deserve mention: the complete, or at least great, resemblance of the archæological finds to articles of culture of the present time in the same localities.

The second day's session, at which Professor McGee presided, was opened by Major Powell, with a paper on the 'Science of Estheology.' Major Powell's entire paper was schematic, as well as exhaustive, and this, together with the fact that the system he presented is but part of a larger systematization, renders it impossible to do it justice by reference to one or two of its points. Mr. James Mooney discussed the Indian Congress at Omaha. He spoke of the growing recognition which this method of ethnologic exhibition was gaining, and dwelt upon the especial opportunities at expositions. The Omaha Congress deserved high praise for the general arrangement of the exhibits and the ingenuity of many of the plans. The unrepresentativeness of the tribes collected, however, was a serious, and on the whole, avoidable defect.

Papers by Miss Cornelia Horsford, on 'Cairns in Southwestern Norway,' which reveal great likeness to those found on the Massachusetts coast, and by A. S. Gatchet, devoted to showing the radical identity, in various American languages, of the terms for real and true, and male, were read in

abstract. The following papers were read by title: 'The Structural Peculiarities of the Eskimo of Smith Sound,' by Dr. G. S. Huntington; 'On the Names Glooscap and Illa Tichi Uira Cocha,' by Mr. Stansbury Hagar; and 'Belief in Will-Power Among the Pawnees,' by Miss Alice C. Fletcher. Dr. Boas represented the anthropologists in the discussion before the Society of Naturalists, and the Section took part in the other exercises and entertainments provided for the affiliated societies.

A. L. KROEBER.

SCIENTIFIC BOOKS.

Revised Text-Book of Geology. By JAMES D. DANA. Edited by WM. NORTH RICE. American Book Company.

It is now more than sixty years since the late Professor Dana produced, in 1837, his first important work, a *System of Mineralogy*. During subsequent years, down almost to the day of his death, in 1895, he was engaged at frequent intervals in writing or revising the several important text-books of geology and mineralogy that have done so much during the last half century to arouse among English-speaking students an intelligent interest in those subjects.

The first edition of 'A Manual of Geology' was published in 1862, the more elementary work, 'The Text-Book of Geology,' following in 1864. So great has been the popularity of the briefer work that extensive revisions were made by the author in 1874 and 1883, while the final revision, begun by him just before his death, has been admirably carried to completion, in the spirit of his old master, by Professor Wm. North Rice, of Wesleyan University.

Professor Rice started out with the plan of retaining the distinctive characteristics of the book, bringing it down to the present time as regards its facts, but still expressing Professor Dana's well-known opinions. Although the general plan of arrangement has been kept unaltered in the main, some radical changes have been made in the interpretation of geological phenomena. Especially is this shown in the treatment of the subject of metamorphism,

where the editor takes a very different view from that held by Professor Dana, and one in harmony with modern thought, when he states that the crystalline schists are 'undoubtedly derived in some cases from granites and other plutonic rocks, a schistose structure being developed by pressure and shearing.'

Another change less radical in its character, but affecting the whole work, is the fuller recognition given to evolution as a factor in geological history. The editor states that from this standpoint he has entirely rewritten the closing chapter, in which the general bearing of paleontology upon evolution is discussed.

The zoological and botanical classifications are much modernized, although the anglicized terminology used by Professor Dana in earlier editions is for the most part followed. Professor Dana's plan of terminating names of rocks in *yte* in distinction from the names of minerals which terminate in *ite* is abandoned on the ground that the innovation in nomenclature has not been adopted by other writers.

In general, however, Professor Rice has faithfully reproduced the well-known opinions of Professor Dana in his revision, but has introduced enough in the way of modern views to make the book a most acceptable addition to our list of elementary text-books of geology. It is not an easy task to revise the work of another, and it often involves much more labor than writing the entire book anew. Professor Rice is to be congratulated on the success of his labor of love in revising 'The Text-Book of Geology,' which, from the earlier relations of teacher and student, he states was entered upon with something like a feeling of filial obligation.

W. B. CLARK.

JOHNS HOPKINS UNIVERSITY.

The Groundwork of Science. A Study of Epistemology. By ST. GEORGE MIVART, M.D., PH.D., F. R. S. New York, G. P. Putnam's Sons; London, Bliss, Sands & Co. 1898. Pp. xviii + 328.

This book forms the second volume of 'The Science Series,' which is now appearing under the editorial supervision of Professor Cattell and Mr. F. E. Beddard. "Each volume of this series," the prospectus sets forth, "will

treat some department of science with reference to the most recent advances, and will be contributed by an author of acknowledged authority." The book before us represents epistemology, or the science of knowledge, in this series. It does not, as one might perhaps expect from the title, treat primarily of the methods of science, or of the fundamental conceptions which science employs, but deals with the essential nature of knowledge, or 'science' in the broader sense, as developed by the human mind, in its relation to a world of real objects.

The table of contents shows the following list of chapters: (I.) Introductory; (II.) An Enumeration of the Sciences; (III.) The Objects of Science; (IV.) The Methods of Science; (V.) The Physical Antecedents of Science; (VI.) The Psychical Antecedents of Science; (VII.) Language and Science; (VIII.) Intellectual Antecedents of Science; (IX.) Causes of Scientific Knowledge; (X.) The Nature of the Groundwork of Science. The author regards as futile all attempts to furnish either a systematic or a historical classification of the sciences. He, therefore, contents himself with an enumeration of them, indicating briefly at the same time some of their more general logical relations.

It will be of advantage to state at once the principal results of the book, and thus to show the main theses which the author defends against what he regards as certain more or less widely prevalent tendencies of the present age. These are as follows: (1) The continuous existence of the Self or Ego; (2) the existence of a real world of extended things in themselves; (3) the necessity of assuming as intuitively known certain propositions which cannot be proved; (4) the possibility of absolute scientific certainty about some things; (5) the existence of breaches of continuity at certain points in the world-process, as, for example, between the organic and the inorganic, between insentient and sentient organisms, and especially between merely sensuous and emotional states of consciousness and the intellectual or rational life; (6) the inadequacy of a purely mechanical or naturalistic theory of evolution, and especially the impossibility of explaining in this way the various

forms of life, and the intellectual and moral nature of man.

We may now look a little more closely at one or two of these propositions. The long chapter, 'The Objects of Science' (pp. 34-88), is occupied almost wholly with a refutation of idealism. The author feels "that if idealism were true, the authority and certainty of other self-evident truths would be gravely compromised, especially if a truth so self-evident as the existence of our own body (as we and most men understand that body to exist) were but an illusion and self-deception of the mind" (p. viii). Unfortunately, Mr. Mivart is here fighting a product of his own imagination. He regards idealism as the doctrine which denies the existence of an external world, and which can be summed up in Berkeley's somewhat unfortunate phrase, 'the *esse* of things is their *percipi*.' His own arguments consist mainly in an oft-repeated declaration that "we have an intuitive knowledge of the external world as extended. "This, of course, is as obvious an example of *ignoratio elenchi* as were the appeals of the Scottish philosophers to 'Common Sense' in behalf of what neither Berkeley nor anyone else has ever dreamed of denying. Moreover, the assertion in this chapter that there is a world of things in themselves, existing apart, and not dependent upon any mind, is sufficiently refuted by the passage with which the book closes. There we are told that "the action of an all-pervading but unimaginable intelligence alone affords us any satisfactory conception of the universe as a whole, or of any single portion of the cosmos which may be selected for exclusive study" (p. 321). In spite of the author's protestations, then, we shall have to regard him as an idealist, in exactly the same sense as we regard Aristotle and Hegel as idealists.

Numerous discussions are devoted to the question of intuitively certain or self-evident truths. The author's position seems to be that all inference rests upon the existence of certain indemonstrable propositions, which have to be accepted as intuitively self-evident (pp. vi, 103 ff, 240 f., 309). These truths are of an entirely different order from the facts known to us by perception or by inference. Each is known as certain and necessary in itself, and this cer-

tainty and necessity are not derived from its relation to anything else. Moreover, these truths are directly apprehended by our power of intellectual intuition (p. 104). It is those fundamental certainties which constitute 'the groundwork of science,' and the author enumerates the list several times with what appears to be slight variations (pp. 106, 241 ff., 310 ff.). In this list are found: (1) the possibility of absolute certainty; (2) the existence of an external world of real objects; (3) our own substantial and continuous personal existence; (4) the possibility of drawing conclusions from premises; (5) the existence of self-evident truths; (6) the law of contradiction; (7) self-evident axioms; (8) the principle of causality; (9) the principle of uniformity; (10) the fact that some things are contingent and some necessary.

It is well-known that Aristotle maintained that all knowledge presupposes the existence of certain self-evident propositions which neither require nor are capable of proof. The earlier Scottish philosophers, also, adopting the same position, made several attempts to furnish lists of self-evident truths. But this doctrine no more belongs to the philosophical thought of to-day than does 'phlogiston' to modern chemistry, or 'vital force' to biology. In the first place, experience has shown that each thinker who defends intuitive truths is likely to have certain propositions of his own which seem to him specially sacred, and which he is anxious to place beyond the pale of examination and criticism. Secondly, what we believe to be a truer conception of the nature of mind, has led us to see that all knowledge is organic—that all of the facts of our experience are interrelated and mutually dependent. There are no truths, then, which are isolated and self-sufficient; every fact is known to be true and necessary only through its connection with other facts. The so-called self-evident propositions must be proved and justified in exactly the same way in which scientific hypotheses are shown to be true. Thus, for example, when I say that it is self-evident that an external world exists, or that nature is uniform, I mean that these propositions are obviously true because in no other way can I

account for the facts of my experience. The proof in these cases may be easier and more convincing than the demonstration of the natural-selection hypothesis, but the former are no more *self-evident* than the latter.

If space permitted, I should like to examine in some detail the doctrine of new beginnings, 'breaches of continuity,' at certain points in the world process. Here, again, it seems to me that the conclusions reached by Mr. Mivart are not in accord with the results of modern scientific and philosophical thought. The modern defender of teleology does not, it seems to me, rest his case upon breaches of continuity in natural law, or upon new beginnings at this point or that. He rather insists that no part of the world—not even the inorganic—can be completely understood without regarding it as the manifestation of an energy in some way analogous, at least, to his own intelligence. If Mr. Mivart had made use of the idealistic principle which he so clearly expresses at the end of his book, and to which I have already referred, he would have found a surer defence against materialism, and would have avoided what must seem to many scientists an attempt to introduce final causes into the field of natural science.

In conclusion, I can not refrain from saying that it seems to me unfortunate that this book should represent Epistemology in a series which undertakes to deal with the most recent advances in the various sciences. The volume doubtless contains a good deal that is interesting and suggestive; but, at the same time, it is at once evident that the writer's special work has been in a different field from that of Epistemology. It seems to me that it is sufficiently clear, from what has been already said, that the author has not followed at all the epistemological discussions of the last twenty years. I add two or three illustrations of very serious confusions with regard to the facts and problems of modern philosophical systems which are not uncommon in the book. "The whole philosophy of Germany and Holland," we are informed, "from Spinoza to Hartmann, has been the result of the mental seed first sown in men's minds by Berkeley, who explicitly produced what was implicitly contained in Locke" (pp.

40-41). This is truly wonderful in view of the fact that Spinoza was dead eight years before Berkeley was born! But even with regard to the later philosophers, the statement is thoroughly misleading. Again, the author might have learned from any standard history of philosophy, without even looking inside Fichte's works, that the statement that 'Solipsism was first developed and upheld by Fichte, though he ultimately abandoned it' (p. 83), is wholly unwarranted. Finally, Mr. Mivart in denouncing the futility of the question: 'How is experience possible?' supposes that Kant and others who have formulated the epistemological problem in this form raised an absurd question as to whether knowledge does or does not exist, and apparently does not at all understand that they were inquiring what conditions its actual existence implies (pp. 56, 275).

Why should one write on a philosophical subject without special knowledge, any more than on biology or physics?

J. E. CREIGHTON.

CORNELL UNIVERSITY.

The Freezing-point, Boiling-point and Conductivity Methods. By HARRY C. JONES, Instructor in Physical Chemistry in Johns Hopkins University. Easton, Pa., Chemical Publishing Co. Pp. 64. Price, 75 cents.

In this book, which is intended as a laboratory guide, the author has not only included the mechanical processes, but has discussed briefly the principles upon which these methods are based. The subject is treated under three heads. In the first part the historical development and applications of the freezing-point method are discussed, as is the boiling-point method in a similar manner in the second part. In the third part the method used to determine the conductivity of solutions and the applications of this method are described. An apparatus for use in the boiling-point method is described by the author which is much simpler than the Beckmann apparatus and very rapid and accurate in its results. The methods described in this book can be carried out in a short time and should be tried by every student of chemistry who is interested in the methods which have done so much to advance our ideas of the nature of solutions.

J. E. G.

Outlines of Industrial Chemistry. A Text-book for Students. By FRANK THORP, PH.D., Instructor in Industrial Chemistry in the Massachusetts Institute of Technology. New York, The Macmillan Co. 1898. Pp. xx+543.

This book aims to furnish an elementary course in Industrial Chemistry suitable for students in the schools of technology. The subjects treated are broadly classified under the heads, 'Inorganic Industries' and 'Organic Industries,' about one-half of the book being devoted to each. Metallurgy has been entirely omitted. Otherwise the topics selected for discussion are essentially the same as in other similar works. The descriptions of processes, while necessarily concise, are clear and interesting. The author has evidently made a careful study of recent methods of manufacture as well as of older, standard processes. The frequent reference to American practice is an important feature which distinguishes the book from other works on chemical technology. A select bibliography follows each subject, and will be found very useful to those wishing to study any topic in greater detail.

W. A. NOYES.

Aperçus de taxinomie générale. Par J. P. DURAND (de Gros). Paris, Felix Alcan, Editeur. 1899.

The title of this book leaves one somewhat in the dark as to the nature of its contents, but a brief perusal shows that its mission is not so much to tell us how to classify as how not to classify. Not that the author does not believe in classification; on the contrary, he considers that everything should be classified and may be classified, provided we adopt the proper methods. What these methods are we are not told; for, after exhorting us to set about fashioning the general science of classification without delay, M. Durand hastens to add that he himself proposes to take no hand in so important an undertaking, preferring rather to stand by and criticise the efforts of others. Towards all existing schemes the attitude of the author is very much like that of the ship-wrecked Irishman who, as he crawled up the beach of the desert island, waved a piece of driftwood about his head, exclaiming: "Whatever form of gov-

ernment I'm under I object to it!" This general dissatisfaction with the present order of things is evinced even in the title, where we find taxinomy instead of taxonomy, this latter word being rejected on the ground that its formation is vicious, a view that should meet with the approval of sticklers for nomenclatorial purity.

Nevertheless, four chapters are devoted to as many orders, or categories, of classification, namely, those of resemblance, structure, degree, (*hierarchie*) and phylogeny (*evolution*), all of which are treated as if they were new discoveries. These chapters contain numerous familiar examples of taxonomic methods as well as sundry ingenious diagrams, all very good in their way, but all more or less familiar to everyone who has had to explain the principles of zoological classification. We are, then, given a discourse on 'the ternary correlation of the four taxonomic orders,' after which M. Durand proceeds to pour the vials of his wrath upon taxonomists and taxonomic systems in general and Haeckel and his genealogical tree in particular. After this we are told that genealogical classification is the only natural method, those founded upon remembrances all being artificial, since they are based upon arbitrarily chosen characters. It is hardly worth while to pursue the subject further, but it may safely be predicted that few will share the author's conviction that his statements are definite and firmly-established facts upon which we may confidently build.

F. A. L.

BOOKS RECEIVED.

Minerva, Jahrbuch der gelehrten Welt. Edited by K. TRÜBNER and F. MENTZ. Strassburg, Karl J. Trübner; New York, Lemoine and Buechner. 1899. Eighth year, 1898-1899. Pp. xxiv+1139.

Transactions of the American Climatological Association for the year 1898. Philadelphia, Printed for the Association. 1898. Pp. xxxiii+243.

The Second Washington Catalogue of Stars, together with the annual results upon which it is based. Prepared under the direction of JOHN R. EASTMAN. Washington, Government Printing Office. 1898. Pp. lxi+287.

The Last Link, Our Present Knowledge of the Descent of Man. ERNST HAECKEL. With notes and biological sketches by HANS GADOW. London,

Adam and Charles Black; New York, The Macmillan Company. 1898. Pp. 158. \$1.00.

The Principles of Agriculture. L. H. BAILEY. New York, The Macmillan Company. 1898. Pp. xx+300.

The History of Mankind. FRIEDRICH RATZEL. Translated from the second German edition by A. J. BUTLER. With introduction by E. B. TYLOR. London and New York, The Macmillan Company. 1898. Vol. III. Pp. xiii+599.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Physical Chemistry, November. 'Potassium Chlorid in Aqueous Acetone,' by J. F. Snell; a study of what the author calls, at Professor E. B. Titchener's suggestion, the *dimeric* surface for the system potassium chlorid, acetone, and water. 'On the Heat of Solution of Liquid Hydriodic Acid,' by F. G. Cottrell; liquid hydriodic acid proves to be an endothermic compound with reference to gaseous hydrogen and solid iodine, but its heat of decomposition is only a little more than a quarter of that of the acid in the form of gas. 'Note on the Transference Number of Hydrogen,' by Wilder D. Bancroft. 'Alcohol, Water, and Potassium Nitrate,' by Norman Dodge and L. C. Graton; a study of the concentration-curve.

December. 'The Conversion of Ammonium Thiocyanate into Thiourea and of Thiourea into Thiocyanate,' by John Waddell; the conversion of thiocyanate into thiourea takes place very slowly, if at all, below 110°, but above 150° is rapid and equilibrium is reached, whether starting from the thiocyanate or from thiourea, when the product contains a little more than 20 per cent. of thiourea. 'Solution Densities,' by H. T. Barnes and A. P. Scott; a study of the density curves for different concentrations of solutions of zinc, magnesium, cadmium, potassium and sodium sulfates, magnesium, zinc, potassium and sodium nitrates, potassium and sodium chlorids, hydrochloric and sulfuric acids. 'Electromotive Force between Amalgams,' by Hamilton P. Cady.

American Chemical Journal, January. 'Metathetic Relations between certain Salts in Solution in Liquid Ammonia.' By E. C. Franklin and C. A. Kraus. 'Some Properties of Liquid Ammonia.' By E. C. Franklin and C. A. Kraus.

The great similarity of liquid ammonia and water in their dissociating power has led to a thorough study of the properties of liquid ammonia. It was found that in a considerable number of cases the nitrates of the metals were acted upon, when in solution in liquid ammonia, by the ammonium salts and a salt precipitated as a result of the metathetic reactions, if the salt formed was insoluble in ammonia. It was also found that many of the physical constants, which in the case of water are so entirely different from those of all other liquids, are almost as strongly characterized in the case of ammonia as in that of water. 'On the Constitution of the Phenylhydrargones:' By P. C. Freer. 'Note on the Action of Liquid Hydriodic Acid on Ethylether:' By F. G. Cottrell and R. R. Rogers. In this case there was a partial conversion of the ether into ethyliodide. 'Contributions to our Knowledge of the Oil of Lemon-Grass:' By W. Stiehl. Isolation of the three aldehydes: Citriodoric aldehyde, Geranial and Allo-lemonal. The *American Chemical Journal* will hereafter appear monthly, and two volumes will be issued yearly.

J. ELLIOTT GILPIN.

WE have received the first issue of *Science Work, a Monthly Review of Scientific Literature*, edited by Mr. Waller Jeffs and published at Manchester by Messrs. Robert Aiken & Company. It is stated in the introduction that the Journal 'will aim to give a general review of the world of science and present the reader as it were with the cream of the scientific press,' but we fear that it will be difficult to do this within the limits of eight pages published twelve times a year.

Natural Science, now published by Mr. Henry J. Pentland at Edinburgh, and still edited anonymously, but under new auspices, opens with the issue for January its fourteenth volume. The general character of the contents, which has always made *Natural Science* interesting and profitable, is well maintained.

SOCIETIES AND ACADEMIES.

GEOLOGICAL SOCIETY OF WASHINGTON.

At the regular meeting of this Society held in Washington, D. C.; January 11, 1899, Mr. Willard D. Johnson, U. S. G. S., read a paper on

'Subsidence Basis of the High Plains,' and Dr. C. Willard Hayes, U. S. G. S., one on the 'Lake Region in Central America.' Dr. Hayes' paper was based upon observations made recently in Central America while working under detail as geologist to the Nicaraguan Canal Commission. Abstracts of both papers follow.

Subsidence Basins of the High Plains.—The Great Plains structural slope has been superficially modified by streams from the Rocky Mountains, in three stages of gradation—a first stage, in which a hard-rock topography was developed by degradation; a second, in which this topography, by aggradation, became buried under an alluvial waste sheet to depths within its valleys as great as 300 feet; the third and present stage, in which the mountain streams are again engaged in cutting and have trenched the aggradation plain with parallel valleys, wide apart. But left thus above grade, this flat surface, in the greater part, has been eroded also by the drainage from its local precipitation. In notable exception is a transverse, mid-slope belt. Here the flat surface suffers no erosion from its local precipitation and has virtually no local drainage. It therefore stands in light relief. Transected by the mountain streams into broad plateaus of faint elevation, it forms a belt of residual tables or upland flats of survival. The Staked Plains plateau, of north-western Texas, constitutes the best individual example. These are the High Plains—to some extent locally so-called. The Great Plains slope has a graduated climate—from humid to arid, east to west. The High Plains correspond in position to its 'subhumid' belt.

In the arid belt to the westward the vegetation—of grass and brush—grows in tufts. It affords but slight protection against the feeble precipitation, and the surface is conspicuously eroded. Upon the High Plains, within the subhumid belt, however, vegetation is wholly of grass, which forms a universal, close-knit sod. This vegetal cover affords complete protection against the considerable local precipitation. The High Plains are distinctively the 'short-grass country.' As a residual topographic belt, within the climatic belt, they are held by their sod. The local precipitation—so much of it as does not evaporate—is absorbed.

These uneroded tables, however, have a faint topography due to subsidence. The flat surface is extensively pitted with saucer-form depressions. Their dimensions vary from a foot or two in depth and a breadth of 100 feet to 75 feet in depth and a breadth of two or three miles. Wind action is plainly to be excluded. Occasionally they are surrounded, upon the hard, sod flats, by concentric cracks, deep enough to cause injury to cattle and to entrap calves.

These forms, large and small, without differences in type, are attributed to the operation of two distinct and unrelated processes: (1) settlement and compacting within the deep and unconsolidated mass of silt sand and gravel, through instrumentality of the ground-water; and (2) solution of salt and gypsum, and consequent caving, within the rocks of the floor, where those rocks are the Red Beds.

The concurrence of two unusual causes, to produce, alike, within a limited area, a result so unusual, appears, however, to be intelligible on this assumption, viz.: These processes are, in fact, of universal operation; they are at the same time of too light effect to stand a chance in competition with erosive agency; but the sod-covered, subhumid plains, remarkable in that they retain a flat surface unscored by erosion, afford exceptional opportunity for the preservation of their delicate record.

The Lake Region in Central America.—The region described includes southern Nicaragua and northern Costa Rica, extending from 10 degrees and 30 minutes to 12 degrees and 30 minutes north latitude, and from the Caribbean to the Pacific. It includes the route of the projected Nicaragua Canal and the largest lakes of the western hemisphere south of the glaciated region of North America. The region is characterized by two types of topography, viz.: (1) the recent volcanic ranges and plateaus in which the original constructional forms are more or less perfectly preserved; and (2) the areas of Tertiary, igneous and sedimentary rocks in which the drainage is mature and the forms are due to long continued subaerial erosion. A noteworthy feature is the absence of any continuous mountain range or chain of dominant peaks through this portion of the isthmus. A shallow

depression occupies the western portion of the region, its longer axis being nearly parallel with the Pacific coast. This contains Lakes Nicaragua and Managua. The former is 110 miles in length, with an area of 3,000 square miles and a mean altitude of 106 feet. Its greatest depth is 200 feet.

The climate of the region is tropical and insular, the annual range of temperature being small. The rainfall is greatest on the east coast, nearly 800 inches at Greytown, and decreases somewhat uniformly westward, being less than 80 inches on the west coast. Connected with the decrease in the rainfall there is a striking change in the character of the vegetation, the dense tropical jungle of the east coast giving place to open forests and savannahs in the west.

No rocks older than the Tertiary are formed along the line of the canal. They consist of eruptive and sedimentary formations, the former including basalt, andesite and dacite, and the latter calcareous sandstones and shales. In addition to these Tertiary rocks there are extensive recent alluvial deposits and the tuffs and lavas of the modern volcanoes. The conditions throughout the region, but particularly in its eastern portion, are favorable for rock decay, and the regolith is unusually extensive.

The late geologic history of the region is briefly as follows: In early Tertiary time this portion of the isthmus may have been wholly submerged. At any rate, marine sediments were deposited throughout a considerable part of its extent, and this was accompanied by intense volcanic activity. In middle Tertiary time there was an uplift and long continued erosion, the constructional volcanic topography being obliterated, and the region, at least toward the south, being reduced to one of low relief. The present basin of Lake Nicaragua was then occupied in part by a gulf connected with the Pacific to the northwest and in part by the valleys of tributary streams. The continental divide then occupied the hilly or mountainous region east of the lake, crossing the present San Juan valley near Castillo. In late Tertiary or post-Tertiary time the isthmus was elevated at least 300 feet and deeply dissected. Following the elevation was a renewal of volcanic activity. A series of vents opened on the

Pacific side and their ejecta built a dam across the outlet of the gulf, thereby forming the lake basin. As this dam increased in height the waters behind it were raised until they overtopped the continental divide and escaped to the Atlantic, forming the present San Juan. The region has suffered a recent depression by which the rivers were drowned, and their estuaries thus formed have since been silted up.

WM. F. MORSELL.

DISCUSSION AND CORRESPONDENCE.

MATTER, ENERGY, FORCE AND WORK.

TO THE EDITOR OF SCIENCE: In the generous and appreciative review by Professor Mendenhall (in SCIENCE, p. 24, January 6) of my book on 'Matter, Energy, Force and Work' there occurs a line to which I would like to advert briefly. "'The something' which distinguishes *substance* from *matter* is *energy*. 'A designated quantity of substance consists of a definite quantity of matter in permanent association with a definite quantity of energy or motion.' The two words 'or motion' render this statement somewhat obscure. What is meant by a 'definite quantity of motion?' Professor Holman's definition of motion is that of nearly all writers, namely, 'change of relative position.' It is a curious but common practice to define it in this way and then to define its 'quantity' by associating with it something (matter, mass) absolutely unlike it in every respect. It is certainly not in this sense that he means to use it in the phrase above quoted."

I desire to express my assent to this comment and to reply to the query therein contained, or rather to remove, if I may, the obscurity. This result will, I think, be effected if for the words 'of motion' in the description of substance be substituted the phrase: *or permanently endowed with some definite mode of motion*.

May I also add, to preclude possible misapprehension, that the proposition 'Continuous, uniform, and permanent occupancy of space,' quoted at page 25, is one which I do not advance as a definition of matter, or as a logical deduction from known premises, but only as a possible view of matter if the *unproved* hypothesis of the kinetic nature of all energy be adopted as a step in the inference.

With sincere thanks for your courtesy in presenting this review, I am

Yours truly,

SILAS W. HOLMAN.

BROOKLINE, MASS., January 17, 1899.

ZOOLOGICAL BIBLIOGRAPHY.

TO THE EDITOR OF SCIENCE: Dr. Dall's 'tolerably active and rather long experience' has been singularly blessed if he has never met with an advance copy of a paper issued at an uncertain date, not offered for sale, and conflicting in its contents with some other paper offered for sale at a known date about the same period; if he or the libraries he frequents have always been able to purchase without a delay of more than one year the new books or pamphlets that he wanted to see; if he has always had so much as a printed postcard in reply from authors whose works he has sought in exchange for his own; and if he has always been able to find the address of every writer with whom he wished to communicate. A restricted and short experience has acquainted me far too thoroughly with all these difficulties, but, as this is not an autobiography, the details need not be inflicted on your readers. Dr. Dall shall have them if he wishes.

Apart from his scepticism, Dr. Dall appears to agree, at least in spirit, with the proposal that he has now twice criticised. But two remarks of his seem to call for reply.

My committee has not yet definitely pronounced on the question: What constitutes publication? But it is safe to say that it does not regard printing as publication, and therefore sees no great value in placing 'the actual date of printing' on every signature. This, too, may be said: That a *British Association* Committee would never recommend an author to sell his papers without an express agreement with the society that has been at the expense of setting up the type, and perhaps of drawing the plates. In our country this may be done, but it is not regarded as particularly creditable to the author that does it. Customs are, no doubt, different elsewhere; but our proposal was an attempt to render the speediest possible publication compatible with commercial morality as recognized here. Perhaps it is this

difference in the point of view that has made our report (as reprinted, not 'abstracted,' in SCIENCE), so unintelligible to Dr. Dall. Another argument for due recognition of the publishing society may be found in such facts as this: A scientific library recently purchased three separate papers, which had been advertised as independent publications and enquired for by readers; all these have since arrived in the regular manner in the report of a society, and the library has as good as thrown away seven shillings through no fault of the librarian. The constant recurrence of this kind of thing renders the authorities very chary of purchasing separately-issued pamphlets, and the workers, few of whom can afford to buy for themselves, have to suffer. Surely any proposal to remedy this should meet with support.

F. A. BATHER.

BRITISH MUSEUM (NAT. HIST.),
January 10, 1899.

NOTES ON INORGANIC CHEMISTRY.

A PAPER was read by Dr. Morris W. Travers before the Royal Society, November 24th, on the origin of the gases evolved in heating mineral substances, meteorites, etc. According to the theory of Professor Tilden these gases are enclosed in minute cavities at high pressure. It is known that some minerals, as quartz, contain liquid hydro-carbons and carbon dioxid, enclosed in cavities, but from a series of exhaustive experiments Dr. Travers concludes that this cannot be the case with the more permanent gases, such as hydrogen, carbon monoxid, nitrogen, helium and argon. He proposes the theory that in the majority of cases where a mineral substance evolves gas under the influence of heat the gas is the product of the decomposition or interaction of its *non-gaseous* constituents at the moment of the experiment. In cleveite and other minerals which contain helium only about one-half this gas is evolved by heat, and hence it would seem that it exists in the form of a compound which is only partially decomposable by heat.

In a series of analyses of atmospheric air from different sources Armand Gautier, in the *Comptes Rendus*, finds that combustible gases con-

taining carbon are present to a variable degree; on high mountains and over the ocean only traces are found, but a decided quantity in the air of cities. More remarkable, and contrary to previous observers, Gautier finds hydrogen as a constant constituent. The amount he gives is 1.5 volumes in 10,000, or half as great as that of carbon dioxid. Fuller particulars are promised in a later article, which will be looked forward to with no little interest.

THE confusion which attends the use of the sign % for both per cent. of weight and per cent. of volume is patent to all chemists as well as others. At the Congress of Applied Chemistry at Vienna it was proposed by Otto Bleier to confine the use of the sign % to per cent. by weight and to use v/v for volume per cent. This was opposed in the discussion by Weinstein. In a recent *Chemiker-Zeitung* Bleier makes a number of proposals, some one of which he hopes will so commend itself to chemists that uniformity may be secured. The proposals, in addition to his original one, are as follows: a. g/g or g/p (or g/g or g/p) for weight per cent., and v/v (or v/v) for volume per cent.; b. g/v or p/v (or g/v or p/v) for weight percent., and v/v (or v/v) for volume per cent.; c. g/g or p/p for weight per cent., and v/v for volume per cent.; d. % for weight per cent., and v/v for volume per cent., or *vice versa*; e. g/g or g/p for weight per cent., and % for volume per cent. Since the sign % is used so much more frequently to indicate per cent. by weight, it would seem that Bleier's original proposal, which is to confine the use of % to weight and to adopt v/v for volume, would be most simple and would speedily reduce the present confusion to a minimum.

THE bacteriological test for the presence of arsenic proposed by Gosio has been further investigated by F. Abba and the results published in the November number of the *Centralblatt für Bakteriologie und Parasitenkunde*. The method consists in growing *Penicillium brevicaulis* close to the substance to be examined for arsenic. arsenic is present a strong garlic odor is developed. The method was found to be successful in testing a series of over a hundred dried hides. As regards its delicacy it was found far superior to Marsh's test, as was shown in one

case when a piece of hide one centimeter square gave a distinct test by the bacteriological test, while five times the quantity failed to respond to Marsh's test. It would be interesting to compare this test with that of Reinsch, which has been found by me decidedly sharper and more to be depended on than that of Marsh.

J. L. H.

ZOOLOGICAL NOTES.

DR. CARLOS BERG notes several occurrences of the Antarctic seal, *Lobodon carcinophaga*, well to the northward of its usual habitat, one example having been taken in the La Plata, near Puerto de Ensenada, and another to the northward of Buenos Ayres in lat. 34° 28' S. This latter was a male captured in June, 1898, and must, from its size, 2.65 meters long, have been an adult animal.

THE *Zoological Record*, Vol. 34, containing a list of the zoological papers which appeared in 1897, has just been issued. Amid the rumors of the many good things that the working zoologist is soon to enjoy, it is a great satisfaction to continue to receive this valuable publication of the Zoological Society of London. Surely, 'A bird in the hand is worth two in the bush.'

CURRENT NOTES ON ANTHROPOLOGY.

ANOTHER MEXICAN CODEX.

FROM a personal letter I learn that Dr. Nicolas Leon, well known for his many contributions to Mexican archæology and history, has discovered a hitherto unknown Mexican Codex in hieroglyphic characters, of which he will soon publish a photo-lithographic reproduction. It dates from the year 1545, and relates to the tributes paid by the town of Tepeal. The proper names of places are written in the usual rebus, or 'ikonomatic' method. They present combinations not found in any of the other known documents of the kind, and some of them are quite puzzling. This discovery will make a welcome addition to the comparatively few specimens of the Mexican graphic method at that date.

THE PROGRESSIVE WOMAN.

A LITTLE book, 'Le Feminisme,' published lately in Paris (Colin et Cie, 1898), has some in-

terest to the student of sociology. Its author, Mlle. Kaethe Schirmacher, gives an accurate sketch of the advance of womankind in social position throughout the world of civilization, beginning with the United States and passing to France, Great Britain, Sweden and Russia. Of our own country she says in her preface that she speaks from personal knowledge. We are gratified, therefore, to know that the characteristics of American women are courage (*hardiesse*), the spirit of initiative and capacity for organization. In France 'feminism' has been principally cultivated by the men, not the women; in Sweden very few women are interested in it, though the King favors it; in England it is opposed by the learned institutions, while in Russia they all favor it. On the whole, the outlook for full and equal rights and opportunities for her sex the author considers cheering.

THE SEAT OF THE SOUL.

UNDERSTANDING by 'soul' the highest intellectual faculties, it is worth considerable trouble to find out where these functions are located. Savages believe that it is in the liver or the heart; cynics suggest that it is in the stomach; phrenologists place them in the front part of the brain; but the most advanced physiologists are now inclined to teach that the posterior cerebral lobes have the highest intellectual value. Dr. C. Clapham's arguments to this effect are quoted with approval in the *Centralblatt für Anthropologie* (1898, Heft 4). These arguments are that man has the most highly developed posterior lobes, and this is conspicuous in men of marked ability and in the highest races. In idiots the lobes are imperfectly developed, and in chronic dementia these portions of the brain reveal frequent lesions. Numerous authorities are quoted in support of these and allied statements.

D. G. BRINTON.

UNIVERSITY OF PENNSYLVANIA.

COLLECTIONS OF THE PROVINCIAL MUSEUM OF VICTORIA, BRITISH COLUMBIA.

A PRELIMINARY Catalogue of the Collections of Natural History and Ethnology in the Provincial Museum, Victoria, British Columbia, 196

pages, 1898, is now being issued. As it deals only with the British Columbian specimens of the exhibition series, the value of the entire collection is much greater than is suggested by the Catalogue.

The list of mammals includes information as to the source of each specimen and the distribution of the species. The catalogue and index of birds, including 339 species and sub-species, is of all those in British Columbia, while the species not represented in the Museum collection are specially indicated by a check mark. It is this mark which will enable the friends of the institution to devote their energies to securing the desired lacking specimens. Very little is known of the birds of the northeastern part of the province. It thus presents an attractive field for research. There are seven cases of bird groups. The catalogue of the study series of 740 bird skins is not published, but it is available to students. The eggs are listed.

Reptilia, Batrachia, Tunicata, Lepidoptera, Beterocera, Coleoptera, Crustacea, Echinodermata, Mollusca are all catalogued. The lists of fish, trees and plants, algæ and the paleontological specimens are extensive.

The ethnological collection is classified in the list under ceremony, dress, amusement, craniology, houses, monuments, fishing, war, travel, domestic utensils and industries. In the introduction to the list of ethnological specimens the visitor is cautioned against assuming that the Indians of British Columbia resemble the Japanese or were influenced by foreigners prior to European contact. Their difference from the Indians of the Plains is mentioned.

It is gratifying to have accessible so complete a list of the natural history and ethnological specimens of the whole province of British Columbia and to know where most of the specimens listed are available.

HARLAN I. SMITH.

SCIENTIFIC NOTES AND NEWS.

PRESIDENT MCKINLEY has appointed as civilian members of a commission to report on the condition of the Philippine Islands: President Schurman, of Cornell University; Professor Dean C. Worcester, associate professor of zoology in the University of Michigan, and Colonel

Denby, for many years United States Minister to China. President Schurman, who is chairman of the commission, has been granted leave of absence until the end of the present year, and Professor T. F. Crane will during the year perform the duties of President.

THE sculptor Herr Ernst Herter has completed the statue of von Helmholtz, which is to be erected in the court of the University of Berlin, between the statues of the two Humboldts. The monument will be unveiled in the spring.

SENATOR PLATT, of Connecticut, has been appointed a Regent of the Smithsonian Institution in the room of the late Senator Morrill, of Vermont.

FATHER RODERIGUES DE PRADA has been made Director of the Observatory of the Vatican.

M. PANAS has been installed as President of the Paris Academy of Medicine, while M. Marey, the physiologist, becomes Vice-President.

THE following officers have been nominated by the French government for its 'Bureau des longitudes': President, M. Poincaré; Vice-President, M. Faye; Secretary, M. Lippmann.

PROFESSOR A. A. MICHELSON, of the University of Chicago, will give, during March, at Boston, a course of Lowell lectures on 'Light Waves and their Uses.'

Nature states that the recent retirement of Sir John Evans from the Treasurership of the Royal Society, after a period of service of twenty years, has given an opportunity for Fellows of the Society to show their appreciation of the efficient manner in which he discharged the duties of his office. It is proposed to have his portrait painted in oil colors, and to hang it on the walls of the Society's apartments at Burlington House.

THE honors annually conferred on New Year's Day in Great Britain include a K.C.B. on Professor W. C. Roberts-Austin, professor of metallurgy in the Royal College of Science, and a K.C.M.G. on Mr. W. T. Thistleton-Dyer, Director of the Kew Botanic Gardens. Sir Henry Thompson, a surgeon, who has also painted

pictures and written novels, has been given a baronetcy, and Dr. Herman Weber, known for his work on the prevention of consumption, has been knighted. Sir Charles Cameron, Medical Officer of Health of Dublin, has been made C.B.

PROFESSOR HENRY ALLEYNE NICHOLSON, regius professor of natural history at the University of Aberdeen, died on January 19th, aged fifty-four years. He was in 1871 called to the chair of natural history in the University of Toronto, and afterwards to Aberdeen. He was the author of important contributions to paleontology.

MAJOR JED. HOTCHKISS, who in 1895 was Vice-President for Geology of the American Association for the Advancement of Science, and who was the author of contributions to economic geology and engineering, died on January 18th, aged 71 years.

DR. WILHELM DAMES, professor of geology and paleontology in the University of Berlin, died on December 22d, aged 55 years.

SIR JAMES MOUAT, K. C. B., a distinguished army surgeon, formerly Inspector-General of Hospitals in Great Britain, died in London on January 4th, aged 84 years.

THE death is announced of Dr. Eugen F. A. Obach, at the age of 46 years. He had made important contributions to electrical engineering and had made a thorough study of the chemistry of gutta percha.

DR. GIUSEPPE BOSSO, of the Turin University, died on January 17th, from infection contracted while cultivating bacilli in his laboratory.

Drs. EHLERT AND MÖNNICH have lost their lives by an Alpine accident on the Susten Pass. Dr. Ehlert had made valuable contributions to seismology, working at the University of Strasbourg. Dr. Mönnich was Assistant to the Bavarian Meteorological Central Station.

THE directors of the Benjamin Apthorp Gould fund, which, it will be remembered, Miss Alice Bache Gould gave somewhat more than a year ago to the National Academy of Sciences, announce that they are now prepared to receive applications for appropriations from the income of the fund, which will amount to about \$1,000

annually. Preference will be given to investigators working in America or to Americans working abroad, and to work in the astronomy of precision rather than in astrophysics. The directors of the fund, to one of whom applications should be addressed, are Messrs. Lewis Boss, Seth C. Chandler and Asaph Hall.

THE Cartwright prize of the Alumni of the College of Physicians and Surgeons, the Medical Department of Columbia University, will be awarded for an essay received not later than April 1st, of the present year. The essay must contain original investigations made by the writer. The value of the prize is \$500 and is open to universal competition.

THE Swiss Society of Chemical Industry offers a prize of 2,000 fr. for an essay that will promote electro-chemical interests in Switzerland. Essays must be sent by May 1, 1900, to the President of the Society, Mitlodi, Switzerland.

THE Washington Botanical Club was organized by a gathering of botanists held at the residence of one of its members November 11, 1898. The limit of membership was fixed at 20, and it was determined that the meetings should be, for the present at least, of a distinctly social and informal nature, with free scope for discussion and the general interchange of ideas. At a subsequent meeting, held December 14th, the organization was perfected by the election of Professor Edward L. Greene as President and Mr. Charles L. Pollard as Secretary. The Club is to hold monthly sessions, devoting itself chiefly to systematic and ecological work, the field of plant physiology and pathology being covered by the already existing Botanical Seminar.

AT the annual meeting of the American Geographical Society, on January 16th, Judge Charles P. Daly, whose services to the Society have been so important, was re-elected President. The other officers elected are: Vice-President, the Rev. C. C. Tiffany; Treasurer, Walter T. Jones; Secretary, Chandler Roberts; Councilors, Rear-Admiral Bancroft Gherardi, William Hamilton, Henry Holt, Clarence King and Charles A. Peabody.

AT the annual meeting of the Philadelphia

Academy of Natural Sciences the following officers, Councillors and members of the Finance Committee, to serve during 1899, were elected :

President, Samuel G. Dixon, M.D.; Vice Presidents, Thomas Meehan, Rev. Henry C. McCook, D.D.; Recording Secretary, Edward J. Nolan, M.D.; Corresponding Secretary, Benjamin Sharp, M.D.; Treasurer, George Vaux, Jr.; Librarian, Edward J. Nolan, M.D.; Curators, Henry A. Pilsbry, Henry C. Chapman, M.D., Arthur Erwin Brown, Samuel G. Dixon, M.D.; Councillors to serve three years, Charles E. Smith, Uselma C. Smith, John Cadwalder, William Sellers; Finance Committee, Charles Morris, Chas. E. Smith, Uselma C. Smith, William Sellers, Charles Roberts; Councillor for unexpired term of two years, Charles Schaffer, M.D.

The following standing committees were appointed for the year :

Publications : Thomas Meehan, Charles E. Smith, Henry A. Pilsbry, Henry Skinner, M. D., Edward J. Nolan, M. D.

Library : Arthur Erwin Brown, Thomas A. Robinson, Henry C. Chapman, M. D., Dr. C. Newlin Peirce and Charles Schaffer, M. D.

Instruction and Lectures : Uselma C. Smith, Benj. Smith Lyman, Samuel G. Dixon, M. D., Philip P. Calvert and Charles Morris.

Committee of Council on By-Laws : Isaac J. Wislar, Theodore D. Rand, Arthur Erwin Brown and Benjamin Sharp, M. D.

THE Ninth International Congress of Ophthalmology will be held at Utrecht from August 14 to 18, 1899. The scientific work of the Congress will be divided among three sections, as follows : (1) Anatomy, Pathological Anatomy and Bacteriology; (2) Optics and Physiology; (3) Clinical and Operative Methods.

THE annual meeting of the Board of Managers of the New York Zoological Society was held on January 17th, with the Hon. Levi P. Morton, the President of the Society, in the chair. The Chairman of the Executive Committee, Professor Henry F. Osborn, reported the important progress in the construction of buildings and other installations, to which we recently called attention. It was announced at the meeting that Mr. Cornelius Vanderbilt had contributed \$5,000 toward the building fund.

THE Finance Committee of the Philadelphia City Council has reported favorably upon a proposed loan of \$200,000 by the city for

the buildings and equipments of the Philadelphia Museums. The bill will probably be passed by the Council, and this insures the raising of the \$300,000 required under the Act of Congress appropriating \$300,000 towards the aid of the exposition of manufactured products of the United States to be held in Philadelphia next autumn. \$50,000 has been appropriated by the State Legislature and \$50,000 has been collected by private subscription. The United States government has also appropriated a further sum of \$50,000 for the purchase of samples of foreign goods to show the kind of goods that should be exported. Dr. W. P. Wilson, Director of the Museums, will be Director-General of the Exposition.

A CHEMICAL and pharmaceutical laboratory has been opened in Rajkote, in western India. 30,000 rupees have been given for the construction of the building by Azam Laxmon Meran. The equipment is paid for by the state. Mr. H. L. Lee has been appointed director of the laboratory.

M. EMILE DUBOIS has introduced into the French Chamber of Deputies a bill providing for the creation in each department of France of one or more bacteriological laboratories, with a view to the repression and prevention of contagious diseases, particularly tuberculosis.

E. C. SIMMONS, ex-Mayor of Kenosha, Wis., has offered to build and present to that city a library building and to purchase 25,000 volumes for it. The estimated cost of the gift is \$100,000.

THE Amesbury (Mass.) public library will receive \$10,000 by the will of the late Mary A. Barnard.

THE corner stone of the School of Practical Horticulture was laid at Hyeres on January 8th, in the presence of M. Viger, the French Minister of Agriculture.

THE Field Columbian Museum, Chicago, has secured, through the generosity of Mr. Stanley R. McCormick, a valuable collection of articles from the Moqui tribes of the Pueblo Indians. It was made by a missionary and represents the arts of the tribes from their earliest association with the pioneers up to the present time.

A TELEGRAM from Sydney has been received

at the Royal Society stating that the boring into the coral atoll of Funafuti had been discontinued on reaching a depth of 1,114 feet. Cores had been obtained, and the material traversed is described as 'coral reef' rock.

THE English papers state that arrangements are being made, under the direction of Signor Marconi, at the South Foreland lighthouse and on board the South Goodwin lightship for a series of experiments in wireless telegraphy. If the experiments are considered satisfactory, it is stated that the wireless system will be adopted forthwith as a means of communication between the South Foreland lighthouse and the South Sands Head lightship. The points of communication are about three miles apart.

THE *British Medical Journal* reports that M. Cruppi recently laid before the French Chamber of Deputies a bill for reforming medical expert evidence. M. Cruppi proposes that a list of medical experts should be drawn up every year. None but men of undoubted scientific ability should be on the list; the accused person should have the right to name his or her own expert, who should work in cooperation with the expert named by the Judge. In cases where the two experts do not agree the matter should be decided by a committee composed of eminent scientific men. The Commission of Judicial Reform is considering the question.

MEN of science will not be surprised to learn that an examination of the late John W. Keeley's exhibition room has brought to light tubes and other arrangements by which compressed air could have been used to run his motor. Wheels went round without doing any work and could have been readily turned by compressed air or in other ways, in the exhibition made some years ago to the present writer. It was at the time indicated that he would be given \$5,000 if he would state over his signature that the operations could not be accounted for by known natural forces.

It is stated in the daily papers that Mr. Elmer Gates, Washington, wishes to form a commercial company to obtain money to enable him to proceed with the invention of his microscope, which he is said to say magnifies 3,000,000 diameters.

UNIVERSITY AND EDUCATIONAL NEWS.

WE regret to learn that the California Courts have decided that the trust clause in the will of the late Adolph Sutro, giving Sutro Heights as a public park to the city of San Francisco, and San Miguel Ranch to support a scientific school, is invalid, and the property will now go into the residuary estate and be divided among six children. Perhaps these children will set the Courts an example by fulfilling the wishes of their father.

THE late Miss Rebecca Flower Squiers, of London, has bequeathed £2,000 for scholarships for students at Oxford or Cambridge, and the residue of her estate, the amount of which is not stated, for the benefit of these universities.

PROFESSOR CLEVELAND ABBE has given to the Johns Hopkins University his valuable collection of books, journals and pamphlets relating to meteorology. The library has also received an anonymous gift of \$5,000 for the purchase of books.

REV. DR. GEORGE E. MERRILL, of Newton, Mass., has accepted the call to the presidency of Colgate University, Hamilton, N. Y.

PROFESSOR J. B. JOHNSON, who holds the chair of engineering in Washington University, St. Louis, has been called to the University of Wisconsin, where he will be made Dean of the College of Engineering.

MR. G. F. STOUT, Anderson lecturer on comparative psychology at Aberdeen and formerly lecturer on psychology at Cambridge, has been appointed to the newly established Wilde lectureship of mental philosophy at Oxford.

THE professorship of physics in the University of Sydney, New South Wales, is vacant. In accordance with the British custom, applications for the position, with eight copies of all testimonials, must be received not later than February 18th by Sir Daniel Cooper, acting agent-general for New South Wales, 9 Victoria St., London, S. W. The salary of the professorship is £900 per annum, with a conditional pension of £400. Candidates must be under 35 years of age. We presume that citizens of the United States are eligible.



OSBORN on *Accratherium incisurum*.

SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; J. LE CONTE, Geology; W. M. DAVIS, Physiography; O. C. MARSH, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; HENRY F. OSBORN, General Biology; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; J. MCKEEN CATTELL, Psychology; DANIEL G. BRINTON, J. W. POWELL, Anthropology.

FRIDAY, FEBRUARY 3, 1899.

CONTENTS:

<i>Frontal Horn on Aceratherium incisum</i> (with Plate I): PROFESSOR HENRY F. OSBORN.....	161
<i>Report concerning the Official State Bureaus connected with the Johns Hopkins University:</i> PROFESSOR WILLIAM BULLOCK CLARK.....	162
<i>The Biological Stations of Brittany:</i> DR. JOHN H. GEROULD	165
<i>Notes on the Times of Breeding of some Common New England Nemerteans:</i> DR. W. R. COE.....	167
<i>The Columbia Meeting of the Society for Plant Morphology and Physiology:</i> PROFESSOR W. F. GANONG	169
<i>Eleventh Annual Meeting of the American Folk-lore Society:</i> W. W. NEWELL.....	173
<i>Scientific Books:—</i>	
<i>Keilhack's Kalender für Geologen, Paläontologen und Mineralogen:</i> J. B. WOODWORTH. <i>Webster on the Chinch Bug:</i> PROFESSOR T. D. A. COCKERELL. <i>Newth's Manual of Chemical Analysis:</i> DR. HENRY FAX. <i>Recent Publications of the U. S. Geological Survey. Books Received.....</i>	174
<i>Scientific Journals and Articles.....</i>	178
<i>Societies and Academies:—</i>	
<i>Wisconsin Academy of Sciences, Arts and Letters:</i> DR. A. S. FLINT. <i>The Ohio Academy of Science:</i> PROFESSOR R. C. OSBURN. <i>Entomological Society of Washington:</i> DR. L. O. HOWARD. <i>The Academy of Sciences of Philadelphia:</i> DR. EDW. J. NOLAN. <i>Zoological Club of the University of Chicago:</i> MARY M. STURGES, PROFESSOR R. S. LILLIE.....	179
<i>Discussion and Correspondence:—</i>	
<i>The Storing of Pamphlets:</i> PROFESSOR WINSLOW UPTON.....	184
<i>Notes on Inorganic Chemistry:</i> J. L. H.....	185
<i>Current Notes on Anthropology:—</i>	
<i>Bad Form in Anthropological Writings; The Mangyans of Mindoro; The Jew and the Gypsy:</i> PROFESSOR D. G. BRINTON	185
<i>Agricultural Education in Russia.....</i>	186
<i>The International Catalogue of Scientific Literature.....</i>	187
<i>Scientific Notes and News.....</i>	188
<i>University and Educational News.....</i>	192

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

FRONTAL HORN ON ACERATHERIUM INCISIVUM.

RELATION OF THIS TYPE TO ELASMOTHERIUM.

IN the classical collection of the Museum of Darmstadt there are the two type skulls of *Aceratherium incisum*, Kaup, which have hardly been disturbed since the death of that distinguished paleontologist. Through the kindness of Professor G. Richard Lepsius, the writer was recently enabled to carefully examine these skulls, which are in a fragile condition. A slight rugosity was observed upon the frontal bones just behind their junction with the nasals, and a very careful examination demonstrated to both Professor Lepsius and the writer the undoubted presence of a rudimentary frontal horn in this typical hornless type. Even more distinctive proof of the existence of a horn is afforded by the characteristic convergence towards the center of the rugosity of a number of small grooves which indicate the course of the blood vessels which supplied the horn. The support of a horn is further indicated by a distinct swelling of the skull above the orbits which is observed with especial distinctness in the profile view. This swelling will probably be found to consist of a thickening of the frontals at this point.

This discovery is of the very greatest interest. In the first place it practically removes this typical Acerathere from the group to which it has given its name and places it among the Rhinoceroses. Second,

the precocious development of the frontal horn, and the marked reduction of the nasals, at once suggested to the writer that this animal may possibly represent an ancestor of *Elasmotherium*, which, as is well known, was distinguished from all other Rhinoceroses by the smooth, narrow nasals and enormously developed frontal horns, as shown in the accompanying figures. It is true that in *A. incisivum* the horns are small, the rugosity, or horn core, being rudimentary; but in paleontology a rudiment is almost invariably prophetic of a fully developed organ in a later horizon. The question whether this type actually marks the first branching-off of the Elasmotheres from the Aceratheres turns, therefore, upon a detailed comparison of the skull and skeleton of the two types. Both skulls are dolichocephalic with high occiputs. A marked difference is seen in the very narrow space between the orbit and nasal opening in *A. incisivum*, as compared with the broad space in *Elasmotherium*. These and other differences may be due to profound changes which occurred during the Pliocene period, for *Elasmotherium* is a well-advanced Pleistocene type. Other profound changes which would be involved in such a transformation are in the loss of old cutting teeth and the folding of the enamel in the molar teeth, so characteristic of the Pleistocene form.

Taken altogether, the evidence that *A. incisivum* is an ancestral Elasmotheres is, however, decidedly slender at present, and we must probably await the discovery of intermediate stages in the Pliocene of Europe or Asia.

HENRY F. OSBORN.

REPORT CONCERNING THE OFFICIAL STATE
BUREAUS CONNECTED WITH THE JOHNS
HOPKINS UNIVERSITY.*

I SUBMIT for your information the following report concerning the Maryland Geo-

* A report presented to the President of the Johns Hopkins University.

logical Survey and the Maryland Weather Service during the past year. Much of the work of these bureaus is carried on in co-operation with the Geological Department, and the offices are provided by the University free of all charges to the State.

THE MARYLAND GEOLOGICAL SURVEY.

The Maryland Geological Survey, which was established by an act of the General Assembly of 1896, began operations upon March 25th of that year, when, by the action of the Commission designated by the act, the organization of the Survey was formally effected. The General Assembly of 1898 passed two additional acts which added largely to the powers of the State Survey Commission by providing for the construction of topographic maps and the investigation of the question of proper highways for the State. By the first act an additional appropriation of \$5,000 annually was granted, while the second act appropriated \$10,000 annually, the original appropriation of \$10,000 annually by the Assembly of 1896 still remaining in force. By these acts the Survey received the very generous appropriation of \$25,000 annually.

During the two and a-half years that the Survey has been in operation several lines of investigation have been taken up, some of which have already been followed to a conclusion. The preliminary survey of the State, in which general information in regard to the geology and economic resources was secured, placed the Survey in a position to inaugurate those lines of investigation which would prove most beneficial to the people of the State and at the same time would contribute most largely to the sum of knowledge regarding the stratigraphy and structure of Maryland. In connection with this general survey there has been maintained a system of collection of statistical data regarding the output of each industry that has to do with the mineral

wealth of the State. Forms are annually placed in the hands of the producers of mineral products, which upon their return are filed at the office of the Survey. In this manner an accurate account is kept of the mineral products of the State, which aggregate in value from six to seven million dollars annually.

The work of the Survey has been systematically divided and a competent man placed in charge of each one of the divisions. Dr. E. B. Mathews, in addition to his duties as Assistant State Geologist, is Chief of the Division of Geology of the Piedmont Plateau; Professor Charles S. Prosser is in charge of the Division of Geology of the Appalachian Region, and Dr. George B. Shattuck is in charge of the Division of the Coastal Plain. The work of the Survey embraces many subjects related to geology, among which is the investigation of our highways, Dr. H. F. Reid being Chief of the important Division of Highways. Dr. L. A. Bauer is in charge of the Division of Terrestrial Magnetism. Several special assistants in charge of independent lines of work are also employed: Mr. A. N. Johnson in Highway Engineering; Dr. Cleveland Abbe, Jr., in Physiography, and Messrs. Basil Sollers and B. W. Barton in Botany.

At the same time active cooperation is maintained with several of the Washington bureaus, especially with the U. S. Geological Survey and the bureaus and divisions of the U. S. Department of Agriculture. The aid which has been rendered by the Washington scientific departments has been of great importance to the successful prosecution of the State work.

The topographic work of the Survey has been much extended during the past year, an area of several hundred square miles having been surveyed upon a scale of one mile to an inch in western Allegany and Garrett counties. The surveying force is

provided by the U. S. Geological Survey through a plan of cooperation between the national bureau and the Maryland Geological Survey.

The magnetic work under the charge of Dr. Bauer was continued in the western part of Maryland. Dr. Bauer completed his work on the western boundary of the State during 1897, and was able to be of great service to the Attorney-General of Maryland, who had the matter in charge. All the magnetic and astronomical work was placed in charge of Dr. Bauer, and he was throughout recognized as the scientific authority upon the State force. During the summer of 1898 a part of Dr. Bauer's time was taken up in the survey of the boundary line between Allegany and Garrett counties, which had been authorized by a special act of the last General Assembly. This work, which had been many times unsuccessfully attempted, was satisfactorily accomplished, and a report published in September.

The more strictly geological work of the Survey was carried on by the instructors and students of the Geological Department of the University, with such cooperation as was deemed necessary along special lines. Professor George P. Merrill, of the United States National Museum, rendered the Survey a very important service in the conduct of the investigations upon the building and decorative stones of the State. Extensive areal and economic work was conducted both in the western and central counties of the State. Surveys of Allegany and Garrett counties were completed and a large amount of data collected for the special economic reports which will appear later.

The highway investigations have occupied the attention of the Survey since the spring of the present year, and a considerable force was employed under the direction of Dr. Reid and his associate, Mr. Johnson, in the study of the highway conditions of

Maryland. The distribution of those rocks which are adapted for highway construction has been carefully surveyed and points for the subsequent locations of quarries of road metals indicated.

The agricultural conditions of the State have also been considered and a study made of many of the relations of the geological formations to the soils derived from them. This classification of the soils has been conducted under a plan of cooperation with Professor Milton Whitney, of the U. S. Department of Agriculture and the Maryland Experiment Station, and, outside of its scientific interest, will prove of much practical benefit to the agricultural interests of the State.

The distribution of plant and animal life is so closely connected with the soils and geology that the Survey plans a study of the fauna and flora from this standpoint. Already some work has been done under the direction of Messrs. Sollers and Barton upon the botany of Maryland, more particularly in the western counties. It is planned in the future to carry on this work in cooperation with the newly organized State Horticultural Bureau.

Much advance was made during the year in the preparation of the manuscript for subsequent volumes. Professor Merrill completed his work upon the Building and Decorative Stones of Maryland, and Mr. Henry Gannett, of the U. S. Geological Survey, furnished an elaborate treatise upon the Aims and Methods of Topographic Work for the report upon the cartography of the State. These and other reports by the regular staff of the Survey are now being collected for the second volume, which will be brought out during the autumn of 1898.

THE MARYLAND WEATHER SERVICE.

The Maryland Weather Service was established in May, 1891, under the joint

auspices of the Johns Hopkins University, the Maryland Agricultural College and the United States Weather Bureau, and became an official organization by an act of the General Assembly approved by the Governor April 6, 1892. Under authority granted by this act the Maryland Weather Service was permanently established at the Johns Hopkins University, under the direction of a Board of Control nominated by the heads of the institutions above mentioned and commissioned by the Governor.

During the first five years of the existence of the Service the investigations were confined largely to a study of the general meteorological conditions of the State. Numerous stations were established in the different counties, volunteer observers having been obtained at a sufficient number of points to render it possible to determine the more important features of the climate of the State. Throughout the same time monthly Meteorological Reports, extending through the year, and weekly Crop Bulletins, covering the growing and harvesting seasons, were published. Two biennial reports to the General Assemblies of 1894 and 1896 were also prepared and subsequently printed with the necessary maps, diagrams and tables. A series of large Climatic Charts was also published and placed on exhibition in the Maryland Building in Chicago at the time of the Columbian Exposition, and copies of the same were subsequently distributed.

Somewhat over a year ago an entire reorganization of the work of the Maryland Weather Service was effected. It seemed desirable to transfer the accumulation of the general climatic data to the Climate and Crop Service of the Weather Bureau, which is much more fully equipped for carrying on that phase of the work, and to devote the money and energies of the Maryland Weather Service to the study of special problems connected with the climatology of the State. It was thought possible, by con-

ducting the work in close cooperation with the State Geological Survey, the State agricultural institutions and the United States Department of Agriculture, to take up lines of research that would be of much permanent value to the people of the State. Arrangements were made for the publication of these investigations in a new series of reports which should conform in all particulars to those already adopted for the State Geological Survey. These volumes, for which arrangements have now been perfected, will contain the results of investigations upon the climate of the State and will include reports upon the physiography, meteorology, medical climatology, agricultural soils, forestry, hydrography, crop conditions, botany and zoology of Maryland.

The reports upon physiography and meteorology are already largely prepared and will constitute the first volume of the series. Dr. Cleveland Abbe, Jr., has prepared a report upon the physiography, while the longer and more elaborate statement regarding the meteorology of the State is divided into three parts, the general treatment of the subject being from the pen of the distinguished Professor Cleveland Abbe, of the U. S. Weather Bureau. Mr. F. J. Waltz, the Local Forecast Official of the U. S. Weather Bureau in Baltimore and the Meteorologist of the State Weather Service, will contribute the part relating to the meteorology of the State; while Mr. O. L. Fassig, his associate, will prepare those chapters which relate to the history of meteorological investigations in Maryland since early colonial days. The cordial support of Professor Willis L. Moore, Chief of the U. S. Weather Bureau, has been secured in this work, as well as in many of the lines of special investigations which will be later pursued.

The investigation of the agricultural soils of the State, already referred to in connection with the State Geological Sur-

vey, are closely related to many of the climatological problems which will be considered in the future, and the active cooperation of Professor Whitney along these lines will add much to the effectiveness of the State work. Mr. C. W. Dorsey, of the State Agricultural Experiment Station, has been carrying on investigations in this field under the supervision of Professor Whitney, and the results of their combined work will be later brought out in the reports of the State Weather Service.

The questions of hydrography are closely related to those of climatology, and already considerable progress has been made in the study of the drainage basins of Maryland through the cooperation secured from Professor Newell, in charge of the Division of Hydrography of the U. S. Geological Survey, and special reports upon this subject will be incorporated in a later volume of the State Weather Service.

The other lines of investigation above referred to have been projected, but little work has been done upon them thus far. They will occupy the attention of the local Service during the coming and subsequent years.

WM. BULLOCK CLARK,
State Geologist and Director State Weather Service.

THE BIOLOGICAL STATIONS OF BRITTANY.

THE marine laboratories of the coasts of France and England can be reached with so little loss of time by students of zoology and botany who live near the Atlantic seaboard in America that a knowledge of the facilities for work at these stations and of their accessibility is of great importance to Americans.

Aside from the hygienic advantages of the ocean voyage and a complete change of scene to a hard-working naturalist who devotes his summer vacations to scientific research, one will in many cases find at some

of the marine laboratories of France or of Great Britain such favorable conditions for his work as cannot be obtained in connection with our own excellent laboratories.

It is with this thought in mind that I call the attention of the readers of SCIENCE to two of the stations for the study of marine biology which are situated in Brittany.

The *Laboratoire de Zoologie Expérimentale* at Roscoff, in Finistère, is under the direction of its founder, Monsieur le professeur de Lacaze-Duthiers, of the Sorbonne, whose hospitality to foreigners is most generous.

Roscoff may be quickly reached from Southampton by the boat to St. Malo, a Breton seaport, or from Harve *via* Paris. It is a quaint old town, with a port devoted to the export of vegetables to England; its narrow streets, among the ancient buildings of the village, are busy with the activities of the honest, sturdy Breton peasantry. The picturesque surrounding country, with its dolmens and menhirs, medieval chateaux and churches, attracts during the summer large numbers of tourists.

The laboratory at Roscoff is a building of the 16th century which faces, on the east, the principal public square. Ivy covered gables and round towers project behind into an enclosed garden. Between the garden and the sea, at the north, is a large grass-roofed aquarium room, with two spacious stone basins in the middle and numerous tanks along the north and south sides of the building. These are supplied with running seawater, which is pumped from a large stone vivarium situated between the aquarium and the sea.

Opening into the aquarium room is the main laboratory for investigators, with eight tables, in addition to which four private work rooms are at the disposal of the Director, besides those of himself and of his staff. The laboratory, which, like the other marine laboratories in France, is supported by the State, is well equipped with reagents,

stains, glassware, etc., and a dark room is provided for photographic work.

As regards the fauna, the fact is to be emphasized that for plankton studies Roscoff is badly situated, whereas for shore collecting its position is admirable. The invertebrate fauna, especially, is very rich. The coast is diversified with numerous rocky islands and with bays which have a bottom of mud, sand or shingle. The spring tides at Roscoff rise and fall, at their maximum, about nine meters, so that a very large area is exposed at low tide.

Thirty-one investigators and elementary students during the summer of 1898 availed themselves of the advantages of this excellent laboratory. The venerable Director of the station made a brief visit in August. The following were engaged with special studies:

Monsieur L. Boutan, the Embryology of *Acmea*, *Haliotis* and *Scallaria*; Professor Y. Delage, Experiments upon Fertilization of the Egg of *Echinus*; Doctor Dominici, Hematopoesis in the Chordata (*Selachians* and *Amphioxus*); Professor P. Francotte, of Brussels, Maturation and Fertilization of the Egg in *Turbellaria*; Dr. J. Georgévitch, of Belgrade, Embryology of *Dentalium*; Dr. N. Koltzoff, of St. Petersburg, Embryology of the Head of *Elasmobranchs*; Monsieur A. Robert, Embryology of *Trochus*; Monsieur P. Vignon, Excretion in the *Crustacea*.

The present writer was occupied with the Embryology of *Phascolosoma*.

Professor Chalon, of Brussels, studied and made collections of the *Algæ*.

The *Laboratoire de Zoologie et de Physiologie maritimes* at Concarneau is under the charge of Professor Fabre-Domergue, of the Collège de France. Founded in 1859 by Monsieur Coste, it is said to be the oldest marine laboratory in existence.

Concarneau is a village of southern Brittany, near the picturesque and beautiful

town of Quimper. Like Roscoff, it can be easily reached by the way of Southampton and St. Malo or from Havre *via* Paris. Fishing and sardine packing are the principal industries of the place. The port and the surrounding country are so picturesquely beautiful that many artists make their permanent residence in the vicinity.

The laboratory is chiefly devoted to fish culture and the study of fishes, although work at the station is by no means restricted to this group. The building has two floors; the first story is devoted to the scientific apparatus, to spacious private rooms for a small number of investigators, a library and a dark room for photography; and the basement contains large stone tanks and other aquaria, provided with running seawater. Large vivaria, designed for holding fish, lobsters, etc., for scientific purposes and for the use of fishermen, adjoin the laboratory and extend out into the sea. The station is well equipped for scientific research. Here Selenka and other eminent zoologists have done much of their best work.

The plankton at Concarneau is said to be very rich, and certain forms of invertebrates which inhabit a sandy shore and which do not occur at Roscoff are found in abundance at Concarneau.

Finally, it should be said that the Directors of these and of other marine stations in France which it has been the good fortune of the present writer to visit are most hospitable and generous to American zoologists. One may be assured that if he goes to the coast of France to study he will receive a hearty welcome.

JOHN H. GEROULD.

STAZIONE ZOOLOGICA,
NAPLES, December 8, 1898.

NOTES ON THE TIMES OF BREEDING OF SOME
COMMON NEW ENGLAND NEMERTEANS.

SEVERAL papers by Professor Bumpus have appeared in this JOURNAL on the

times of breeding of invertebrates at Woods Holl, Mass. In connection with these the following notes on the nemerteans may prove of interest to some who may desire to carry on researches on the embryology of this neglected group of worms.

It does not seem to be generally known that the eggs of some of our nemerteans can be obtained in abundance at almost any season of the year; that those of many species can be artificially fertilized, and that they will develop readily in confinement. Even in the case of those which undergo an indirect course of development the embryos can readily be reared to the early pilidium-stage. The eggs of some of the common species, moreover, are so very transparent that many of the phenomena involved in maturation, fertilization and cleavage can be followed in the living ovum without the use of stains. For these reasons they afford most promising objects for embryological and cytological investigation.

1. The eggs of *Amphiporus ochraceus* Verr. are laid during the months of May and June (or sometimes earlier) in the vicinity of New Haven. Worms which are kept in captivity sometimes deposit their ova in clusters of forty or more imbedded in a common mass of mucus. They develop readily in confinement, and the young worms may be kept alive until they attain a considerable size. As in most other Hoplonemerteans the development is direct.

2. *Amphiporus virescens* Verr. Eggs mature at Woods Holl in July and August. They develop readily when laid in captivity, although the number of eggs produced by a single worm is small.

3. *Tetrastemma candidum* Oersted. Mature in July and August at Woods Holl and New Haven.

4. *Tetrastemma vermiculus* (Quatr.) Stimp. Common on piles at Woods Holl with ripe ova in August.

Several other species of *Tetrastemma* and *Amphiporus* have been found mature in mid-summer.

5. *Emplectonema giganteum* Verr. has been found by Professor Verrill with large eggs in August.

6. *Lineus viridis* Johnson = *L. gesserensis* Müller = *Nemertes obscura* Desor = *Lineus obscurus* Barrois. On the Coast of Maine Verrill* has found the eggs of this species very abundant under stones at low-water mark. These were imbedded in mucus and were deposited in mid-summer. At Woods Holl during three summers I have examined thousands of specimens but have found no eggs. On the northern coast of Europe the eggs are mature from March to May. The development of this species was studied by Desor† as early as 1848 from material which he collected near Boston in February. Barrois‡ and, later, Hubrecht§ have published detailed descriptions of its embryology.

7. *Lineus socialis* (Leidy) Verr. The eggs mature in mid-winter at New Haven, and are sometimes deposited in captivity in masses of mucus. They develop readily at least to the stage of swimming gastrulæ.

8. *Lineus bicolor* Verr. Specimens dredged in Vineyard Sound in July, 1898, contained mature genital products.

9. *Micrura affinis* Verr. Specimens taken off Salem by Professor Verrill contained fully developed eggs and spermatozoa in mid-summer.

10. *Micrura caeca* Verr. Matures its genital products at Woods Holl during August. The eggs of this species are beautifully clear and transparent and develop readily when artificially fertilized. The cleavage

is of the regular spiral type, of which these eggs furnish an almost ideal illustration. The pilidium which results will live two weeks or more in confinement.

11. *Cerebratulus lacteus* Verr. The eggs are ripe at New Haven during February, March and April. On the coast of Maine the species is said to breed in early summer. I have never observed that the eggs are deposited in captivity. Specimens filled with eggs have been kept alive in the laboratory for more than two months after the time of full maturity of the sexual products without discharging their eggs. Whether they would be capable of normal development after this length of time I was unable to determine, because all the males which could be obtained had long since discharged their spermatozoa. The worms attain an enormous size (up to 22 feet in length and an inch in breadth, according to Verrill) and consequently produce an immense number of ova. I should estimate the number to be obtained from a fair-sized worm—say, 5 feet long—to lie between fifty thousand and a quarter of a million. A single individual, or even a small fragment, will thus furnish all the material required for an elaborate investigation. The eggs are easily fertilized artificially, and will develop into the pilidium-stage without difficulty.

12. *Cerebratulus Leidyi* Verr. Breeds commonly at Woods Holl in July and early in August. In 1898 the majority of the individuals which I found at Woods Holl had discharged their genital products earlier than July, and in 1894 a few specimens at New Haven retained their ova as late as October. Among the nemerteans that I know, the eggs of this species are equalled in beauty and regularity of development only by those of *Micrura caeca*. The first division occurs about one hour and ten minutes after fertilization, or in 55 minutes if the eggs have been allowed to

* *Trans. Connecticut Acad.*, Vol. 8, 1892.

† *Boston Journ. Nat. Hist.*, Vol. 6, 1848.

‡ *Recherches sur l'embryologie des Nemertes*. Lille, 1877.

§ *Proeve eener Ontwikkelingsgeschiedenis van Lineus obscurus*. Utrecht, 1885.

remain in the water until the formation of the first polar spindle, before being fertilized. The second cleavage takes place about 24 minutes later; the third cleavage occurs after 30 minutes more; the fourth after another 35 or 40 minutes; and after a further lapse of about 50 minutes, or in a little less than $3\frac{1}{2}$ hours after fertilization, the fifth division, with its resulting 32 cells, is completed. A very symmetrical blastula appears about $7\frac{1}{2}$ hours after the eggs are fertilized, and in $1\frac{1}{2}$ hours more the embryos begin to swim. The third cleavage, which is distinctly right-handed, shows the first differentiation of the cells in regard to size; the upper four, or those next to the polar bodies, being slightly, though perceptibly, larger than the lower four. The cleavage is typically spiral and almost perfectly regular. There are only the slightest indications of a vitelline membrane, so that the polar bodies are lost at an early stage. The near equality in the size of the blastomeres also tends to increase the difficulties encountered in following out the details of the cell-lineage. The pilidium with peculiarly short side-lobes, which develops from these eggs, will live for two weeks or more in the laboratory, although I have never seen the young nemertean develop within it.

13. *Cerebratulus luridus* Verr. Specimens collected in Cape Cod Bay by Professor Verrill contained apparently ripe eggs in August.

14. *Carinella pellucida* Coe ripens its sexual elements in July at New Haven and Woods Holl.

15. *Parapolia aurantiaca* Coe. Genital products mature in August at Woods Holl.

16. *Valencinia rubens* Coe. A single specimen found at Woods Holl in August 1894 was filled with ripe spermatozoa.

17. *Cephalothrix linearis* Oersted. At Woods Holl this species commonly matures its genital products in August. The eggs may be artificially fertilized. The

development is direct and may be readily followed. McIntosh* has published figures of the embryos of this species.

The above includes merely those dates at which genital products have been found mature, and should by no means give the impression that they may not be found in some of the species at other times, both earlier and later than is here indicated. The times when the eggs are normally deposited is certainly liable to considerable variation. *Amphiporus ochraceus*, for example, has on one occasion been found mature as early as January, although the eggs are produced more abundantly four or five months later. In this respect the nemerteans agree with many other invertebrates. In some others, as *Cerebratulus lacteus*, the time during which the eggs can be fertilized lasts for a few weeks at the most, and this period, at New Haven, varies from February to April according to some undetermined peculiarity of the season.

It will be seen that of the common species recorded here nearly all become sexually mature on the southern coast of New England during the summer months. Only one lays its eggs in mid-winter and only two in the very early spring.

W. R. COE.

YALE UNIVERSITY.

THE COLUMBIA MEETING OF THE SOCIETY
FOR PLANT MORPHOLOGY AND PHYSIOLOGY.

THE second annual meeting of this Society was held in conjunction with the meetings of the American Society of Naturalists and the Affiliated Societies at Columbia University, December 27 to 30, 1898. On the evening of December 27th a reception was tendered to the members of the Society and visiting botanists by the Torrey Botanical Club of New York, and the Society

* British Annelids; Part I., Nemerteans. Ray Society, 1873.

joined with the Affiliated Societies in the entertainments of Wednesday and Thursday evenings, and in the annual discussion on Thursday afternoon. On Friday a visit was made to the New York Botanical Garden, where the grounds and buildings were shown and explained by the Director, Dr. N. L. Britton. At the business meeting the following officers were elected for the ensuing year: President, Dr. J. M. Macfarlane; Vice-Presidents, Professor G. F. Atkinson and Professor D. P. Penhallow; Secretary, Dr. W. F. Ganong. The following new members were elected: Messrs. F. C. Stewart, C. O. Townsend, F. C. Newcombe, B. D. Halsted, J. B. Pollock, D. S. Johnson, L. M. Underwood, M. B. Waite. The President, Dr. W. G. Farlow, presided over the sessions, at which the following papers were read. Detailed abstracts of these will appear in the February number of the *Botanical Gazette*:

Some Peculiar Morphological Features of Paulownia imperialis: DR. J. W. HARSHBERGER, University of Pennsylvania.—This paper contained a discussion of noteworthy anatomical, ecological and morphological features in this introduced tree, particularly in buds, flowers, fruits and petioles.

The Life-history of Leuchtenbergia principis (abstract): DR. W. F. GANONG, Smith College.—This paper is an attempt at a complete life-history of this rare and highly specialized species of Cactaceae, whose development has hitherto been quite unknown. This contribution is offered as the first of a series of life-histories in this family intended to supply data for a better understanding of phylogeny and of principles of morphology and ecology.

Observations upon Root-tubercles: PROFESSOR B. D. HALSTED, New Jersey Agricultural College.—The author's observations showed that the root tubercles on spring-grown beans of a certain variety are much more abundant than upon autumn-grown plants

of the same variety grown in the same soil. He discusses the reasons for this, finding that of temperature, directly or indirectly, most important, and points out the bearing of his facts upon some others which have puzzled students of the subject.

Further Notes on the Embryology of the Rubiaceae: MR. F. E. LLOYD, Teachers' College.—The author described very peculiar features in the development of the ovule and seed in several members of this family, including the development of as many as eight or ten macrospores in one ovule, very large antipodal cells, and the development of haustoria from the suspensor which absorb the endosperm.

The Inflorescences and Flowers of Polygala polygama: MR. CHARLES H. SHAW, University of Pennsylvania.—In this paper it is pointed out that in this well-known species there are, in addition to the commonly recognized aerial and subterranean cleistogamic blossoms, other green cleistogamic blossoms borne above ground, the characters of which are remarkably intermediate between those of the other two kinds. A full comparison of characters makes this plain.

Observations on some Monocotyledonous Embryo-sacs: MR. R. E. B. MCKENNEY, University of Pennsylvania.—The author described an unusual method of development of the embryo-sac in two species of *Scilla*, and discussed its significance. Incidentally he gave attention to the centrosome question, and was unable to find them in any of the stages studied, thus confirming the work of Mottier and others who doubt their occurrence in the higher plants.

The Structure and Relation of the Crystal Cells in Sensitive Plants: MR. R. E. B. MCKENNEY, University of Pennsylvania.—It is here pointed out that the crystals in cells sheathing the phloem in sensitive plants are insoluble in the ordinary reagents and possibly are made of insoluble silicates. They are also more abundant in the more

sensitive species, and peculiar features are found in the cells containing them. The author thinks it probable they are connected with the transmission of stimuli, the real place and nature of which are not yet known.

The Structure and Parasitism of Aphyllon uniflorum: MISS AMELIA B. SMITH, University of Pennsylvania.—This paper, preliminary in character, described the anatomy of this species and its characters of degeneration due to its parasitism upon a species of *Aster*.

On the Occurrence of Tubers in the Hepaticæ: DR. M. A. HOWE, Columbia University.—The author calls attention to the few known cases of tuber formation in *Hepaticæ*, and gives a detailed account of the anatomy of the tubers in *Anthoceros phymatodes*, a California species. He interprets these tubers as structures adapted to carry the life of the plant over a season of drought and also as playing a part in vegetative propagation.

Morphology of the Genus Viola: DR. HENRY KRAEMER, Philadelphia College of Pharmacy.—The author has made a detailed microscopical examination of selected characters, particularly in the flower, in several species of the genus *Viola* as a basis for the determination of the phylogeny of those species, and he gives a preliminary classification of those investigated. The work is the continuation of earlier published studies, and is part of a detailed investigation the author expects to make of the entire genus.

Influence of Electricity upon Plants: DR. G. E. STONE, Massachusetts Agricultural College.—The paper contains the results of experiments upon some 20,000 germinating plants to which electrical stimuli were applied by various methods and in different intensities. The author shows, by careful quantitative methods, that, within certain limits, germination is accelerated by the application of electricity; that there is a

latent period and a minimum, optimum and maximum response, and that the relation between perception and stimulus follows Weber's Law.

Notes on the Germination of Spores: DR. C. O. TOWNSEND, Maryland Experiment Station.—The author describes results of experiments made to determine the effect upon their germination of exposure of spores in distilled water to different external conditions. Such exposure, as shown by comparison with control experiments, produced no appreciable effect upon the power of the spores to germinate, except when they were frozen, in which case they failed to germinate at all.

Sensitiveness of certain Parasites to the Acid Juices of the Host Plants: DR. ERWIN F. SMITH, Department of Agriculture.—This paper describes the author's experiments made to determine whether his hypothesis, based upon observation, is correct, that the slow progress of some bacterial diseases of plants is due to the restraining influence of the acid juices of the host plants. By comparison with the results of cultures in solutions of known acidity, he was able to confirm this belief.

Further Observations on the Relations of Turgor to Growth: DR. CARLETON C. CURTIS, Columbia University.—The author described the results of experiments in altering the strength of solutions in which certain fungi were being cultivated, and the effects of the transfer upon growth and turgor force.

Symbiosis and Saprophytism: PROFESSOR D. T. MACDOUGAL, University of Minnesota.—The author points out that the term saprophyte, or holosaprophyte, should be applied only to those forms that obtain organic products without the aid of mycorrhiza, etc., and that hitherto but a single seed-forming plant has been placed in this category. To this, however, the author now adds *Cephalanthera* as result of his researches.

Influence of Inversions of Temperature and Vertical Currents of Air upon the Distribution of Plants: PROFESSOR D. T. MACDOUGAL, University of Minnesota.—As a result of observations made at Flagstaff, Arizona, the author concludes that inversions of temperature through diurnal changes and resultant air currents are more important in affecting plant distribution than has hitherto been supposed. Such changes tend to give minor highlands a more equable temperature than adjoining hills and cañons; to deflect zonal boundaries on great level plains and among minor topographical features, and to favor the growth of moisture-loving species along the margins of table-lands bordering on valleys.

Peculiarities of the Distribution of Marine Algae in North America: Presidential Address, DR. W. G. FARLOW, Harvard University.—This address, illustrated by maps, discussed the distribution of North American Marine Algae with particular reference to the factors, temperature, direction of ocean currents, character of coasts, etc., determining it. It is expected that it will later be published in full.

Some Appliances for the Elementary Study of Plant Physiology: DR. W. F. GANONG, Smith College.—The author exhibited and described some simple and inexpensive appliances invented by him for illustrating some of the more fundamental physiological facts and phenomena of plants. These included a temperature stage, a clinostat, a self-recording auxanometer, an osmometer, a way of demonstrating the exchange of gases in respiration, a germination box, a useful way of preparing plants for transpiration weighings, and an efficient way of graduating growing roots, etc.

Some Notes on the Reproduction and Development of Nereocystis: PROFESSOR CONWAY MACMILLAN, University of Minnesota.—The author described his observations upon the life-history of this species, giving par-

ticular attention to the ecological aspects of the subject.

The Formation and Structure of the Dissepiment in Porothelium: DR. E. A. BURT, Middlebury College.—The author traced the development of the fructifications of *Porothelium fimbriatum* from their origin to the tube stage, and contrasted the structure of the dissepiment in different cases.

Gelatin Culture Media: DR. ERWIN F. SMITH, Department of Agriculture.—The author spoke of the value of gelatin culture-media and pointed out certain precautions to be observed in its use, particularly with reference to the fixing of the melting-point, the occurrence in it of sugar and of acid salts, and how the influence of these may be overcome.

Notes on the Relative Infrequency of Fungi upon the Trans-Missouri Plains and the Adjacent Foothills of the Rocky Mountain Region: DR. CHARLES E. BESSEY, University of Nebraska.—An abstract of this paper, given by Dr. Erwin F. Smith, showed that the author had noted, in the course of his fourteen years' collecting of fungi in the region named, that the number of species of fungi is large while the number of individuals is small, exactly the opposite of what is true in the same region for the flowering plants.

Different Types of Plant Diseases Due to a Common Rhizoctonia: MESSRS. B. M. DUGGAR, Cornell University, and F. C. STEWART, New York Experiment Station.—The studies of the authors have shown that a stem rot of the carnation is due to a fungus agreeing precisely with *Rhizoctonia Beta*, which has caused a serious rot of sugar beets in New York during the past year. The fungus is described and suggestions given for its treatment.

The Stem Rot Diseases of the Carnation: MR. F. C. STEWART, New York Experiment Station.—The author points out that two distinct diseases of carnations have been confused. One is that described by him-

self and Mr. Duggar (in the preceding paper), and another is due to a *Fusarium*. The differences in the effects of the two are described.

W. F. GANONG,
Secretary.

SMITH COLLEGE, NORTHAMPTON, MASS.

ELEVENTH ANNUAL MEETING OF THE AMERICAN FOLK-LORE SOCIETY.

THIS meeting, held in connection with the affiliated societies, at Columbia College, on December 28th and 29th, was indicative of progress. According to the report of the Council the number of members had remained about constant, amounting to about five hundred. The report of the Treasurer showed that annual receipts and expenses were about equal. As the next volume of the series of *Memoirs of the Society* was announced a second part of 'Current Superstitions,' by Mrs. Fanny D. Bergen, including those relating to animals and plants; the first part of this work forms the fourth volume of the *Memoirs*, of which six volumes have now appeared.

As officers for 1899 were elected Professor C. L. Edwards, of the University of Cincinnati, President; Miss Alice C. Fletcher, Washington, First Vice-President; Mr. C. F. Lummis, Los Angeles, Cal., Second Vice-President. The Secretary and Treasurer hold over.

A committee was appointed to take into consideration the subject of the collection and record of folk-music, and to propose plans for the more adequate collection of negro folk-music in America.

The address of the retiring President, Dr. Henry Wood, of Johns Hopkins University, dealt with 'Folk-lore and metaphor in literary style.' The object of the speaker was to exhibit the dependence of the consciously artistic metaphor of literature to the traditional metaphor which forms its underlying basis.

Among papers read may be mentioned observations on 'The study of ethics among the lower races,' contributed by Dr. Washington Matthews. The writer considered the study of myths and traditions to be the safest guide in this field, which as yet has scarcely been traversed; but in the use of such material it is necessary to proceed with caution and employ the critical methods of modern science. If the gods of the tribe are considered as approving any action, or if the author of the tale appears to look for the approbation of his audience, it may be concluded that the act is regarded as possessing a moral quality, however, repulsive it may appear according to our ideas. That there exists a strong sense of the morality of conduct is obvious from the security of life; thus the Navahoes live in entire peace without courts or punishments. With this people there exists no penalty for theft; the thief is merely required to restore the stolen property. According to the myths incest is presumed to be confined to witches and cannibals. Truthfulness is not inculcated as a duty, yet Dr. Matthews had found the veracity of the people to be about equal to that of the whites. Expectation of reward in a future life does not exist. Conscience forms an effective power. The tales attest the frequency of active benevolence.

Mr. W. W. Newell offered some observations on the relation, in sun-myths, of the visual impression to the symbolic conception. He pointed out the antiquity and universality of the radiant disk as a solar symbol, arguing that the effect on the sight must have been constant. He considered the variety of the myths to be the result of causal explanations, the orb being considered as an object somehow to be got through the sky, treating of the Indian myths regarding the sun-bearer, who is often confounded with the orb he carries. Dr. Boas observed that among the Kootenay, for

example, the sun is regarded as an animal; but perhaps it was conceived that the light emanated from a certain part of the creature, just as in the numerous myths where the luminous disk is regarded as part of the decoration of a sun-bearer.

Mr. A. L. Kroeber presented a collection of animal tales of Eskimo, in part as made by himself from Smith Sound Eskimo. In these tales there is a contrast between Indian and Eskimo conceptions. Among Indians animals play an important part and are conceived as human in character. With Eskimo, on the contrary, animal stories are few; they belong chiefly to two classes, the first describing a marriage between a human being and an animal, the second answering to European beast fables. The paucity and brevity of the latter differentiate them from the Indian narratives. Dr. Kroeber subjoined a list of recorded Eskimo animal tales.

Dr. Livingston Farrand read a paper on the 'Mythology of the Chilcotin,' in which the relations of the tales of this people with those of their neighbors was discussed, with a view to obtaining a criterion in regard to the vexed question of diffusion or independent origination of similar myths. Dr. Farrand concluded that identity of theme was of minor importance as proof of borrowing, while agreement in details, among races contiguous or in communication, could be explained only on the hypothesis of diffusion.

Notes on American Indian names of white men and women were presented by Dr. A. F. Chamberlain, of Clark University, and 'Contributions toward a bibliography of folk-lore relating to women,' by Mrs. Isabel Cushman Chamberlain.

Miss Cornelia Horsford communicated information in regard to traditions connected with an apparent footprint on a rock of Shelter Island.

Other papers were offered by Dr. Robert

Bell, Professor Thomas Wilson and Mrs. F. D. Bergen. Demonstrations were made of phonographic records of Indian song.

W. W. NEWELL.

SCIENTIFIC BOOKS.

Kalender für Geologen, Paläontologen und Mineralogen. Herausgegeben von DR. K. KEILHACK. 2d annual edition, 1899, with a portrait of Professor C. W. v. Gümbel. Leipzig, 1899, published by Max Weg. Pp. 288, with blank pages for notes. Price, 3 Marks.

A handbook for geologists comparable to the numerous pocket aids, edited for the use of engineers, has never been issued. Dr. Keilhack began in 1898 the work, which is here described, in such a way as to fill some of the needs for such a book of reference. The list of contents of the present edition will serve as a sufficient notice of the booklet. The work gives a list of the official geological surveys of all countries, including the American States, with their officers, the maps published, the prices of the maps and information concerning the other publications of the surveys. Where possible, the annual money allotment is stated. Secondly, a list of the professors and instructors in geology, paleontology and mineralogy in the colleges and high schools of the world, alphabetically arranged by towns. It is to be noted that the American high schools do not rank as 'high schools' of European grade. Hence American high-school teachers are not here named. Thirdly, a list of geological, paleontological and mineralogical societies, with a brief account of their publications and membership. Fourth, the addresses of geologists, etc., of Germany, Holland, Australia, Switzerland and Hungary. Fifth, the public and private geological, mineral and paleontological collections of the countries just named. Sixth, the subdivisions of the greater geological formations in Europe. Seventh, a tabular view of the massive rocks, after Zirkel. Eighth, the characteristics of common minerals, giving their system of crystallization, specific gravity, hardness, chemical composition, streak color and the crystallographic position of their leaf cleavage. Ninth, a comparative table of the

crystallographic systems of Naumann, Weiss and Miller, with formulas for converting the symbols of one system into those of another. Tenth, atomic weights of the elements. Eleventh, an essay on the history of the names of geologic formations, by J. Walther. Twelfth, rules for the termination of proper names in scientific literature. Thirteenth, a brief notice of the advance of geology for the year. Fourteenth, list of geologists who have died since October 1, 1897. Fifteenth, table of the commonly-used measures of length. Sixteenth, isogonic chart of Europe for 1899. Seventeenth, lists of periodicals now published. Eighteenth, a list of geological, paleontological and mineralogical literature for 1898. (Very incomplete, particularly as regards America, and frequently useless because name of periodical is not given.) Following is a chart of map scales, a daily calendar, a few blank pages for accounts, and blank and cross-section pages for geologic notes. Then come 26 pages of advertisements of German materials for use in geologic investigation and teaching. Worthy of notice among these advertisements is Professor Dames' Geological Globe, of 34 cm. diameter, which will be useful in every geological laboratory.

The writer found the first edition of this book an invaluable *vade mecum* in a European trip. At home the book serves as a valuable check-list for the sending of separates, for information concerning geologic maps, and while it is not particularly adapted to the American geologist it is a welcome addition to the reference books one keeps about his desk. A handbook for the field geologist has yet to be written. Just what such a book should contain is probably difficult to ascertain.

J. B. WOODWORTH.

The Chinch Bug. By F. M. WEBSTER. Bull. No. 15, N. S., Div. of Entomology, U. S. Dept. of Agriculture. [November] 1898. Pp. 82.

This excellent bulletin deals with a subject of perennial interest to farmers and entomologists; and although the literature of the chinch bug is already large, Professor Webster has found plenty of new and interesting things to say about it. In the most interesting and convincing way, he shows how the insect may have origi-

nated in Central America, and spread northward in three columns, one along the Pacific coast, the second over the prairie region east of the Rocky Mountains, and the third along the shores of the Gulf of Mexico and Atlantic ocean. On p. 72 a map is given illustrating these migrations. The Pacific column appears to be weak, and is little known, but the other two are strong in numbers. In the course of these migrations the insects have become modified, and it is clearly shown that the Atlantic and prairie hordes differ both in habits and structure. Just at this point the present writer is inclined to disagree with Professor Webster's opinion, that there is only one species of *Blissus* in North America. There are reasons for believing that we have at least three species, and Montandon (Ann. Soc. Ent. Belg., XXXVII., 1893) has described as new *B. hirtus* from North America, and *B. pulchellus* from Central and South America. Unfortunately, I have not access to these descriptions, but from the data furnished by Professor Webster we may separate the following:

1. Form of Central America and the West Indies: Macropterous, perhaps of larger average size than the North American type. This may be Montandon's *pulchellus*.

2. Form of the prairie region of North America, probably also of California: Macropterous, more slender and less hairy than the coast insect. This is doubtless Le Baron's *Rhyparochromus devastator*, and will be called *Blissus devastator* (Le Baron). This insect occurs in small numbers, and is evidently native, along the eastern base of the Rocky Mountains, in Colorado and New Mexico. Like the Colorado potato beetle, it has become destructive when, moving eastwards, it found the cultivated fields of the central States. Professor Webster shows that it is very destructive to wheat and corn, but rarely attacks timothy. It has two annual broods.

3. Form of the coast region and northeastern States. This is doubtless the true *Blissus leucopterus*, Say. It has both brachypterous and macropterous forms, and is somewhat broader and decidedly more hairy than *devastator*. It depredates almost exclusively upon timothy grass and is single-brooded.

4. Another brachypterous sea-coast form, quite hairy and with colorational peculiarities, has been found at Lake Worth, Florida, and Fortress Monroe, Virginia, as recorded by Dr. L. O. Howard. I do not know whether this is Montandon's *hirtus*.

It seems to the writer that the probability of there being at least three species among the above insects is great enough to deserve serious consideration. If those who have the material will boil up a number of each in caustic potash, and examine the structural characters under the microscope by transmitted light, it is probable that new differences will appear, especially in the male genitalia. If it can be established that the seriously destructive insect of recent years is *B. devastator*, and not *B. leucopterus* at all, and that the former is still migrating eastwards, the fact will not only be of scientific but of economic importance.*

T. D. A. COCKERELL.

MESILLA PARK, N. M.

November 24, 1898.

Postscript, December 9th. Dr. L. O. Howard writes me: "The eastern form [*leucopterus*] injures many plants, including rice. That it is apparently more resistant to fungus attack, however, was shown in a curious way last summer, when it damaged grass lawns in the heart of the City of Brooklyn in an abnormally wet season and in spite of repeated drenchings from the sprinkler hose."

A Manual of Chemical Analysis, Qualitative and Quantitative. By G. S. NEWTH, Demonstrator in the Royal College of Science, London. New York, Longmans, Green & Co. 1898. Pp. vii + 462.

This book is a decided departure from the usual manuals of qualitative and quantitative analysis. The author has endeavored, and with much success, to present a book which will teach the theoretical as well as the practical side of analytical chemistry and to avoid as far as possible teaching mechanical opera-

tions. He has divided the volume into two parts: Book I., of 136 pages, treating of qualitative analysis; and Book II., giving the methods of gravimetric and volumetric analysis of inorganic substances, including the analysis of the more simple gases, of the determination of carbon, hydrogen, nitrogen, sulphur and the halogens in organic compounds, and of some simple physico-chemical experiments.

The subject of qualitative analysis is treated in a broad way, and the student who follows the text conscientiously will obtain a wide knowledge of general chemistry. The author first shows how the subject can be classified according to the reaction with the group reagents, and then considers the properties of the separate elements. The general chemistry of each of the more common elements is discussed, giving only those properties which are useful for the separation and identification of the elements in analysis, and after having considered the properties of a group of elements there is given a summary of the particular properties which are utilized in separating the members of the group. The general reactions taking place, the properties of the substances and their compounds are so clearly stated and the subject is so logically developed that the qualitative separation of the substances follows naturally, and the quantitative separation is but a step further. This is particularly true of that portion of the book which treats of the oxidation and reduction of iron, chromium and manganese compounds. The reactions of chromium and the separation in the presence of phosphates, which are often difficult points for the student to grasp, are fully and satisfactorily explained. The separation of iron, chromium and aluminium is based upon the oxidation of chromium to chromic acid by sodium peroxide and the solubility of aluminium hydroxide in sodium hydroxide, and should commend itself more favorably than the usual methods of separation for this group. Another point which deserves special mention is the fact that after each group follows an appendix in which the properties of the rarer elements of that group are considered. The concluding chapter of the portion of the book devoted to qualitative analysis is full of sound advice on the in-

* On p. 50 Professor Webster notes that few chinch bugs died from the parasitic fungus in the timothy meadows of northern Ohio. These were the *B. leucopterus*, which, coming from a relatively damp region, may have acquired greater powers of resistance to the fungus attack than *B. devastator*, from the dry prairies of the far West.

telligent interpretation of results and on the cultivation and development of habits of observation.

There are some points on which the author has either not laid enough stress or where a better method of procedure might have been offered. The difficulties produced by the simultaneous presence of chromium and zinc are not mentioned, and it would have been much better to have given here, as an alternative method, the barium carbonate process, not only for the separation of zinc from chromium, but also for the separation in the presence of phosphates. Again the Fresenius method for separating small amounts of barium, calcium and strontium would prove more accurate than the separation by means of potassium chromate and acetic acid. The preliminary tests and operations necessary to get a substance into solution are systematically treated, but no mention is made of fusion with acid potassium sulphate. There are two portions of Book I. which reflect on the intelligence of the student, and the book would have been much better without them, viz.: the tables at the end of each chapter giving an outline of the process; and Chapter I., which treats of filtration, solution, evaporation, fusion, precipitation, ignition and neutralization, processes, which properly belong to experimental general chemistry. If the student had not already been over the ground here given he would not be fitted to begin qualitative analysis.

There will undoubtedly be a difference of opinion concerning that portion of the book devoted to quantitative analysis, particularly in regard to the selection of the gravimetric analyses and to the details necessary to carry them out. After the preliminary operations of weighing and preparation of pure salts the gravimetric determination of the more common metals and acids is studied in detail, and then follows a chapter on the determination of the constituents of silver coin, solder, German silver, bronze, dolomite, zinc blende and an insoluble silicate containing the alkalis. The well known typical methods of volumetric analysis are given. By excluding many descriptive details and by conciseness and clearness of expression the author has condensed a

great deal into this portion of the book, which, if followed under the guidance of an instructor, should give any student a good general knowledge of quantitative methods.

Following the gravimetric and volumetric methods, the physico-chemical methods for the determination of specific gravity, boiling point, melting point and vapor density are given. The author could very advantageously, and should, have included here the determination of molecular weights by boiling- or freezing-point methods, and then followed it by a brief *résumé* of the more recent applications of theoretical chemistry to quantitative analysis. Such a chapter would have been in harmony with the rest of the book and would have increased its value greatly.

In his preface the author says, "I have carefully avoided the use of those symbolic abbreviated expressions, such as H_2O (oxalic acid), H_2T (tartaric acid)," etc., and nevertheless he uses the formula 'Cy' instead of CN, offering as an excuse that 'Cy' is a recognized and convenient symbol for the radical (CN) cyanogen. He is further inconsistent in the uses of the doubled formulæ for the hydroxides of iron, chromium and aluminium, as $Fe_2(OH)_2$, etc., while perhaps in the same equation he will use the single formula for the chloride $FeCl_2$.

The author it seems takes unusual precautions in igniting filter papers apart from the main portion of the precipitate. This tedious operation might have been avoided in many cases by the use of the Gooch crucible, which receives no mention.

As a whole the book is remarkably free from objectionable points, and is a distinct advance in the scientific treatment of analytical chemistry.

HENRY FAY.

RECENT PUBLICATIONS OF THE U. S. GEOLOGICAL SURVEY.

THE following bulletins have been recently issued by the U. S. Geological Survey:

Bulletin 89. 'Some Lava Flows of the Western Slope of the Sierra Nevada, California,' F. L. Ransome.

The author describes a series of lava sheets, one of which forms the celebrated Table Moun-

tain, in Tuolumne county, California, and which has been usually described as basalt. The rocks are intermediate between the trachytes and andesites and are specially named 'latites.' Inasmuch as six other names have already been proposed for rocks of this general character, the author had a magnificent opportunity to resist the temptation to make a new one.

Bulletin 149. 'Bibliography and Index of North American Geology, Paleontology, Petrology and Mineralogy for 1896,' F. B. Weeks.

This bulletin continues the excellent series already represented by Nos. 127, 130, 135 and 146.

Bulletin 150. 'The Educational Series of Rock Specimens, collected and distributed by the U. S. Geological Survey,' J. S. Diller.

The petrography of the series is set forth by Mr. Diller and others. The work will be more fully reviewed elsewhere in SCIENCE.

Bulletin 151. 'The Lower Cretaceous *Gryphaea* of the Texas Region,' R. T. Hill and T. W. Vaughan.

This Bulletin has been reviewed in SCIENCE for January 20, 1899 (p. 110), by Professor Frederic W. Simonds.

Bulletin 152. 'Catalogue of the Cretaceous Plants of North America,' F. H. Knowlton.

Bulletin 153. 'Bibliographic Index of North American Carboniferous Invertebrates,' Stuart Weller.

Bulletin 154. 'A Gazetteer of Kansas,' Henry Gannett.

Bulletin 155. 'Earthquakes in California in 1896 and 1897,' Charles D. Perrine.

Bulletin 156. 'Bibliography and Index of North American Geology, Paleontology, Petrology and Mineralogy for 1897,' Fred. B. Weeks.

The titles of Nos. 152-156 inclusive indicate the contents.

THE Macmillan Company announce the early publication of the second part of Dr. Davenport's 'Experimental Morphology, which treats of the effect of chemical and physical agents upon growth. They also announce 'A History of Physics; in its Elementary Branches Including the Evolution of Physical Labora-

tories' which has just been completed by Florian Cajori, Ph.D., professor of physics in Colorado College and author of 'A History of Mathematics.'

THE Open Court Publishing Company have now in press the 'Principles of Bacteriology,' by Professor Ferdinand Hueppe, of the University of Prague, translated by Professor E. O. Jordan, of the University of Chicago.

BOOKS RECEIVED.

Hand-book of Metallurgy. CARL SCHNABEL. Translated by HENRY LEWIS. London and New York, The Macmillan Company. 1898. Vol. I., pp. xvi + 876. Vol. II., pp. xiv + 732. \$10.00.

A Guide to the Study of the Geological Collections of the New York State Museum. FREDERICK J. H. MERRILL. Albany, University of the State of New York. 1898. Pp. 207 + 65 plates. 40 cents.

Earthenware of the New York Aborigines. WILLIAM M. BEAUCHAMP. Albany, University of the State of New York. 1898. Pp. 76 + 142. 245 illustrations. 25 cents.

The Last Link, our present Knowledge of the Descent of Man. ERNEST HAECKEL. London, Adam and Charles Black; New York, The Macmillan Company. 1898. Pp. 156. \$1.00

The Principles of Stratigraphical Geology. J. E. MARR. Cambridge, The University Press; New York, The Macmillan Co. 1898. Pp. 304. \$1.80.

Society for the Promotion of Engineering Education Sixth Annual Meeting, Vol. VI. Edited by T. C. MENDENHALL, J. B. JOHNSON and A. KINGSBURY. Published by the Society. 1898. Pp. xxvii + 324.

Traité de zoologie concrète. YVES DELAGE and EDUARD HÉROUARD. Vol. VIII., Les procordes. Paris, Schleicher Frères. 1898. Pp. vii + 379.

SCIENTIFIC JOURNALS AND ARTICLES.

THE New England Botanical Club has established a journal to encourage the study of the local flora. It has been given the name *Rhodora* and will be published monthly at 740 Exchange Building, Boston. The editor-in-chief is Mr. B. L. Robinson, with Messrs. F. S. Collins, M. L. Fernald and Hollis Webster as associate editors. The first number, which contain twenty pages and two plates, opens with an editorial announcement, followed by a number of inter-

esting articles and notes on the flora of New England.

THE initial number of the *Bulletin* of the Cooper Ornithological Club of California contains a biographical sketch, with portrait of Dr. James C. Cooper, after whom the Club is named. Among the other contributions is one on the 'Nesting of the Fulvous Tree-Duck,' showing that this species frequently deposits its eggs in the nests of other species, and also that it is either more prolific than any other duck, or that several females lay in one nest, 28 to 32 eggs being found on several occasions.

THE publication of the *Osprey* for December, 1898, brings this magazine down to date, and we are promised that there will be no delays in the future. The leading article, by E. W. Nelson, is devoted to a 'Morning with the birds on Mount Orizaba,' and there is an interesting account of the Sea-birds off the New England coast by H. K. Job. A fine plate of blue jays, by Fuertes, closes the number, but this, like the other illustrations, has suffered in the printing.

THE *Bulletin* of the U. S. Fish Commission for 1897, Vol. XVII. of the series, is mainly occupied with the papers read at the National Fisheries Congress, held at Tampa, Fla., in January, 1898. Among the other papers are accounts of the Salmon Investigation of the Columbia River Basin in 1896, and of the Salmon Fishery of Penobscot River and Bay in 1895 and 1896.

THE February number of *The Open Court* contains an article by Professor R. M. Wenley, of the University of Michigan, on the Gifford Lectureships, established with an endowment of \$400,000, by the late Lord Gifford, in the four Scottish Universities, for the purpose of encouraging research in natural theology. In his will Lord Gifford stated that he wished the lecturers to treat their subject strictly as a natural science—as astronomy or chemistry is treated. The present incumbents of the lectureships are: At St. Andrews, the Hebrew scholar, Professor Wellhausen, of Marburg; at Glasgow, the physiologist, Professor Foster, of Cambridge; at Aberdeen and Edinburgh, Professors Royce and James, respectively, professors of philosophy and psychology at Harvard University.

SOCIETIES AND ACADEMIES.

WISCONSIN ACADEMY OF SCIENCES, ARTS AND LETTERS.

THE 29th annual meeting of the Academy was held on December 27th and 28th last, at Milwaukee, with the President, Professor C. Dwight Marsh, of Ripon College, in the chair.

Professor E. A. Birge, Director of the State Geological and Natural History Survey, made a report on the general progress of the Survey. Dr. E. R. Buckley followed with a special report on Wisconsin building stones and Professor D. P. Nicholson on lake investigations. Professor C. R. Van Hise and others urged that the recommendation of the Academy for the continuation and extension of the Survey be presented formally to the Legislature. A committee was appointed for this purpose.

It was voted as the sense of the meeting that the library of the Academy should be put in the custody of the State Historical Society when the latter should remove its own library to the new building provided for it by the State. The library of the Academy has become important, especially in the line of transactions of foreign societies, and it is expected that suitable rooms will be available for it in the new building.

Mr. Ernest Bruncken, Secretary of the State Forestry Commission, reported on the legislation which the Commission will endeavor to gain the present winter. Three lines of effort will be recommended: (1) to establish a complete corps of fire wardens and efficient supervision thereof; (2) to study conditions of forest growth, both in the forest itself and at experiment stations; (3) to educate public opinion.

The program of the meeting contained, together with other papers, the following of a scientific nature:

'Lake temperatures.' E. A. Birge.

'Contributions from the histological laboratory of the University of Wisconsin.' W. S. Miller.

'Further facts in relation to the succession-period of generations.' C. H. Chandler.

'Lantern Projections of Three Dimensional Curves and Surfaces,' and 'Theoretical Investigation on the Motion of Ground Waters—III, Mutual Interference of two or more Artesian Wells.' C. S. Slichter.

'The Maximum Gravitational Attraction at the Pole of a Spheroid.' E. F. Chandler.

'Combinations of Pythagorean Triangles as giving Exercises in Computation.' T. H. Saford.

'A Study of the Class of Electric and Magnetic Oscillations known as Aphotic.' J. E. Davies.

'Some Facts in Regard to the Development of *Epischura*.' C. Dwight Marsh.

'The Block System of Arranging Insect Collections.' Harriet B. Merrill.

'Spines of Trilobites and their Significance.' G. L. Collie.

'The Crystallography of a Gold Telluride from Cripple Creek,' and 'The Crystallography of a new Reduction Product of Terpene.' W. H. Hobbs.

'The Volume Relations of Original and Secondary Minerals in Rocks.' C. R. Van Hise.

'The Electrical Properties of Non-Aqueous Solutions.' A. T. Lincoln.

'The Effects of the Presence of pure Metals upon Plants.' Louis Kahlenberg and E. B. Copeland.

'Revision of the Pronouns, with Special Consideration of Relatives and Relative Clauses.' E. T. Owen.

The number of new members elected was 14. The active members of the Academy now number 200.

A. S. FLINT,
Secretary.

MADISON, WIS.

THE OHIO ACADEMY OF SCIENCE.

THE Ohio Academy of Science held its eighth annual meeting at Columbus, Ohio, on December 29 and 30, 1898, in Orton and Zoological Halls of the Ohio State University. Eighteen new members were elected. Hon. Emerson McMillen, a life member of the society, donated the sum of \$250 to be applied as the trustees of the Society may see fit, for the encouragement of investigation. Officers were elected for the coming year as follows: President, Professor G. Frederick Wright, of Oberlin; Vice-Presidents, Chas. E. Albright, of Columbus, and A. D. Selby, of Wooster; Secretary, E. L. Mosely, of Sandusky; Treasurer, Professor Herbert Os-

born, of Columbus; Executive Committee, E. E. Masterman and G. H. Holferty; Publication Committee, F. M. Webster, of Wooster.

Professor W. G. Tight, of Dennison University, delivered the retiring President's address on the subject 'Geographical Teaching and the Geography of Ohio.'

The following papers were read: 'A Deep Pre-Glacial Channel in Western Ohio and Eastern Indiana,' by J. A. Bownocker; 'The Division of the Macrospore Nucleus of *Erythronium*,' 'Two Interesting Filamentous Bacteria from Columbus' and 'Nutation of the Cultivated Sunflower,' by John H. Schaffner; 'Some Recently Discovered Pre-Glacial Cols in Ohio,' 'A Galenite Geode from Muskingum Co.' and 'A Pocket Instrument for the Approximate Determination of Distance by Triangulation,' by W. G. Tight; 'Some Observations on *Unio subovatus*,' by F. L. Landacre; 'Some Observations on the Topography of Athens and Vicinity,' by H. E. Chapin and C. H. Stearns; 'The Laboratory and the Field—Their Relative Importance,' by H. E. Chapin; 'A Contribution to the Knowledge of the Faunistic Entomology of Ohio,' 'Some Notes on the Grape Cane Gall Maker, *Ampelogypter sesostris*,' and 'Some Apparent Relations of Ants to Peach aphid, *A. persicæ-niger*,' by F. M. Webster; 'Some Observations on the Pre-Glacial Drainage of Wayne and Associate Counties,' by J. H. Todd; 'A Plea for Science Teaching in the Public Schools,' by Miss Mary E. Law; 'Notes on Ecological Plant Geography of Summit, Wayne and Medina Counties' and 'Field Notes,' by A. D. Selby; 'Some Sources of the Ohio Flora,' by A. D. Selby and J. W. T. Duvel; 'Notes on Fasciation,' 'Some Abnormal Plant Specimens' and 'Further Studies in Embryology,' by Miss L. C. Riddle; 'Distribution of the Microscopic Fungi,' 'Reliability of Spore Measurements of the Fleishy Fungi,' 'The Illinois Biological Station' and 'Occurrence of Phalli near Cleveland,' by H. C. Beardsley; 'Climate of the Philippine Islands,' 'Life in the Philippines' and 'Some Rare Ohio Plants,' by E. L. Mosely; 'Development of the Microsporangium of *Hemerocallis fulva*,' by E. L. Fuller; 'Lichens New to Ohio,' 'List of Phænogams New to Ohio or Rare in and New to Coun-

ties in Northern Ohio' and 'Lists of Erysiphæ and Uredinæ of Cuyahoga and other Counties of Northern Ohio,' by Edo Claassen; 'Studies of *Ustilago Reiliana*,' by W. A. and K. F. Kellerman; 'Plants New to the Ohio Flora' and 'Observations on the Ohio Flora,' by W. A. Kellerman; 'A Descriptive List of the Fishes of the Big Jelloway Creek System,' by J. B. Parker, E. B. Williamson and R. C. Osburn; 'Additional Notes on Franklin County Fishes,' by E. B. Williamson and R. C. Osburn; 'Additional Notes on the Crayfish of Ohio,' by E. B. Williamson; 'Additions to the Ohio List of Dragonflies,' 'Additions to the Ohio List of Butterflies' and 'Twenty-five Species of Syrphidæ not Previously Reported for Ohio,' by J. S. Hine; 'Remarks on the Hemipterous Fauna of Ohio, with a Preliminary Record of Species,' by Herbert Osborn; 'A Bat New to Ohio,' by J. F. Cunningham; 'A Female of the Purlain Sawfly, *Schizocerus* Sp.?, with a Male Antenna,' by C. W. Mally; 'The Waste or Refuse in Fruit and Nuts,' by W. R. Lazenby; 'On the Occurrence of the Black-Capped Petrel, *Estrelate hasitata*, at Cincinnati, Ohio,' by Joshua Lindahl.

R. C. OSBURN.

ENTOMOLOGICAL SOCIETY OF WASHINGTON.

January 12, 1899.—Under the head of exhibition of specimens Mr. Schwarz showed a true queen of an undescribed species of *Termes* which had been found by Mr. H. G. Hubbard in the Madera Cañon of the Santa Rita Mountains, Arizona. This is the first true Termite queen which has been found in North America.

Mr. Heidemann exhibited a species of the genus *Hoplinus* found by Mr. Schwarz in southern Arizona (Catalina Mountains). This is a curious species thickly covered with spines, on account of which Mr. Ashmead suggested that, as the vegetation of that region is spiny, the presence of this armatured bug indicated a case of protective resemblance. A long discussion ensued on the subject of mimicry and protective resemblance among insects, participated in by Messrs. Gill, Ashmead, Judd and Howard.

Dr. Dyar presented some notes on the phylogeny of the Lasiocampidæ. Apropos of Mr. Tutt's recent article on the subject he had gone

over the group and established a genealogical tree based principally upon the larval characters and the wing venation. The discussion of this paper took the form of a continuation of the subject of protective resemblance suggested by Dr. Dyar's remarks about the larvæ of this group of Lepidoptera, especially in relation to the sub-lateral structures developed as a means of eliminating the shadow cast by the caterpillars, consisting in one group of larvæ of a longitudinal white line and in others of lateral processes. Further discussion, by Messrs. Gill, Ashmead and Dyar, considered the larval characters of the Lepidoptera, Dr. Dyar stating that the most generalized larva is tuberculate, tubercules being lost and hairs being developed in the process of specialization.

Mr. Schwarz read a paper by Mr. H. G. Hubbard on the luminosity of a larviform Coleopter supposed to be the female of *Mastinocerus*, and supplemented Mr. Hubbard's note by general remarks on the females of Lampyrid beetles. Discussion followed, relating especially to the question as to whether luminosity in the Lampyridæ is a specialized condition, Dr. Gill taking the stand that from its more or less isolated occurrence in several groups of this family it is more likely to have been an original condition which has been lost perhaps by a majority of species in the process of specialization, calling attention to the analogy between this phenomenon in the Lampyridæ and Elateridæ to the phenomenon of electricity in the fishes, occurring as it does here and there in several groups. Mr. Schwarz stated that the relationship between the luminous Lampyridæ and the Elateridæ was closer than perhaps has hitherto been suspected and called attention to the fact that the larviform female of *Phengodes* was originally described by Le Conte as an Elaterid. Mr. Howard considered that from the fact that the species which lack this physiological quality correspond to the normal coleopterous type and that since the larviform females possess what may be termed highly degradational characteristics comparable to those acquired by a life of parasitism, for example, the luminosity should probably be considered a high specialization of comparatively recent origin.

The final paper of the evening was presented

by Mr. Howard who exhibited a series of Australian insects of economic importance and made a brief statement of the present condition of economic entomology in the Australian colonies. He called attention to the fact that the introduction of agriculture on a large scale in this comparatively new region had resulted in the attacks of many native species upon cultivated crops. The specimens shown had been sent him by Mr. W. W. Froggatt, the Entomologist of the Department of Agriculture of Sydney, New South Wales, and included a number of species of great economic importance. He noted the curious habit of the apple root-borer (*Leptops hopei*) in laying its eggs in the folded leaf of the apple, the newly hatched larvæ dropping to the ground and entering the roots; the damage done by the orange bug (*Oncosalis sulciventris*), the vine moth (*Agarista glycina*) and a number of other species, showing among other things that the so-called climbing cut-worm named by Mr. Froggatt *Plusia vertiserrata* is apparently nothing but our North American *Prodenia lineatella*. In briefly discussing this paper Mr. Schwarz drew a comparison between the large number of native species which, by a change of habit, have attacked cultivated crops in Australia and the extremely small number which have similarly changed their habits in our own Northwest. He recalled no native species in Washington and Oregon which have become crop pests.

L. O. HOWARD,
Secretary.

THE ACADEMY OF NATURAL SCIENCES OF
PHILADELPHIA.

December 20, 1898. PROFESSOR ANGELO HEILPRIN made a communication on the physical geography and geology of the Klondike region, with incidents of a summer trip to Dawson City. The general features of the country traversed were described and profusely illustrated by lantern views.

A paper entitled 'Synopsis of the United States species of the Hymenopterous genus *Centris* Fabricius,' by William J. Fox, was presented for publication.

January 10, 1899. PROFESSOR H. A. PILSBRY described a New Mexican Helicoid land shell

received from Professor Cockerell. A dissection showed that the form agreed with the Epiphragmophora in the structure of the generative organs and the form of the kidney, while the shell closely resembles *Polygyra*. The new genus thus defined was named *Ashmunnella* in recognition of the services of the collector.

DR. WILLIAM H. DALL referred to the discussion at the recent meeting of the Geological Society of America of the authenticity of the Calveras skull, and described the specimen as examined by him immediately after it came into the possession of Professor Whitney, of the Geological Survey of California. The speaker believed that so far no sufficient reason had been adduced for doubting the genuine character of the skull and its original situs below the lava, though the question of the coexistence of man and the extinct mammals whose remains have been found in the same gravels is entirely distinct and may reasonably be left open.

The subject was discussed by Mr. Lewis Woolman, who also referred to recent ineffectual attempts to find implements of human manufacture in the Trenton gravels.

A paper entitled 'New and Interesting Species in the Isaac Lea Collection of Eocene Mollusca,' by Charles W. Johnson, was presented for publication.

January 17, 1899. MR. CHARLES S. BOYER read a paper on the general study of diatoms and on the characters of the forms found in the neighborhood of the mouth of Pensauken creek and elsewhere near Philadelphia.

MR. LOUIS WOOLMAN dwelt on the geological position and characters of the deposits containing the forms enumerated by Mr. Boyer and exhibited microscopic preparations in illustration of his remarks.

PROFESSOR ANGELO HEILPRIN, alluding to Dr. Dall's communication on the Calveras skull, recounted the arguments for and against its authenticity recently presented to the Geological Society of America. Heregarded the present evidence of the miners as worthless. He had calculated the age of the cañon to be quite consistent with the existence of Indians cotemporaneous with the deposit of the skull, although he agrees with Dr. Dall that, with the

evidence now in our possession, the question could not be definitely settled.

MR. P. P. CALVERT referred to a recently published paper on the structure of the gizzard of dragon flies and recounted the results of the recorded observations. He had been able to dissect out the gizzard, in good condition for study, from dried specimens, one having been obtained from a fly captured in Burmah in 1889. The ridges, which form a prominent feature of the organ, do not seem to be smoothed away by food, their function being probably that of a sieve.

EDW. J. NOLAN,
Recording Secretary.

ZOOLOGICAL CLUB, UNIVERSITY OF CHICAGO.
MEETINGS OF THE AUTUMN QUARTER.

Polymorphic Nuclei in Embryonic Germ-cells.—While studying the oogenesis of *Loligo pealei* Les., the squid common at Woods Holl, Mass., I noticed that the embryonic germ-cells showed nuclei much lobed and contorted—a condition which has been observed in other germ-cells and variously accounted for as due to amitosis; to deterioration with accompanying fragmentation, to increase of the assimilating surface, etc. I wish here briefly to call attention to this condition in the squid. An account of the oogenesis will soon be completed.

Sex first becomes distinct shortly after hatching, the embryonic germ-cells being apparently indifferent. During and for a short time after the embryonic period the genital gland rests upon the left tongue of the internal yolk-lobe. Nourishment is evidently direct through the yolk-epithelium, the genital blood-vessels developing toward the end of this period. During this time the nuclei of the germ-cells enlarge rapidly and show marked lobes, bays and contortions, a centrosome occurring in one bay of each nucleus. Their descendants, the oo- and spermatogonia, also show a polymorphism of the nuclei which becomes less striking as the number of generations increases and the size of the cells decreases. These cells always lie near the blood-vessels of the gland, and their chromatin, like that of the parent cells, is never finely divided, but massed in clumps, a large clump lying near each bay of the nucleus. A similar

though less marked polymorphism exists in nearly all the somatic nuclei at this embryonic period, and is conspicuous in those rapidly proliferating stroma-cells at the hilum in which the blood-vessels form.

This condition of the nuclei in the germ-cells of the squid is due neither to deterioration nor to amitosis, for it is shown by all the germ-cells, which after attaining a large size divide by mitosis, giving rise to the oo- or spermatogonia. It seems probable that it is here caused by the rapid growth of the nucleus, together with the retention of the centrosome and massed condition of the chromatin in these rapidly dividing embryonic cells.

MARY M. STURGES.

Larvæ of Arenicola cristata.—The highly resistant organization of these larvæ renders them remarkably well fitted for artificial rearing. They may be reared from the egg in sea water kept aerated by *Ulva* up to a stage where the structure and habits of the adult are practically complete. Addition of carmine powder to the sea water seems to accelerate development up to a certain point, probably on account of the increased food supply which is thus furnished to the developing larvæ.

They leave the egg-strings as slightly elongated, strongly heliotropic larvæ with two eye-spots and three body segments, each with two pairs of setæ. Prototroch and paratroch, together with a median ventral band of cilia, are present, and by their aid the larvæ swim about, actively rotating on the long axis at the same time. After a day or two they settle down and begin to form the tubes in the interior of which they undergo the remainder of their development. These tubes are of very simple construction, being composed of any convenient foreign particles united by a glutinous substance secreted apparently by certain large clear cells, situated anteriorly, which are to be regarded as gland-cells. From now on development progresses uniformly and growth proceeds as usual by the addition of segments at the posterior end. The opacity resulting from the presence of the yolk gradually diminishes as the yolk becomes absorbed, and when twelve segments

or so are present the larvæ have become almost perfectly transparent. By this time the mouth and anus have appeared and the three divisions of the intestine are established, the mid-gut, or stomach, which is very early distinguishable, being sharply marked off from the fore- and hind-guts, the latter of which is ciliated. The anterior part of the fore-gut is eversible and forms a proboscis, which appears at an early stage, and by its activity the neighboring particles of *débris* are taken into the intestine, and as they pass through the latter the food material is extracted, just as in the adult.

The essential habits of the adult are thus assumed at a very early stage. As the larva grows older the uniform segmentation of the body undergoes an alteration, and by the time thirty segments or so are attained there is perceptible a division of the body into two quite distinct regions, which correspond to a similar division in the adult, where the anterior part of the body, including the first eighteen segments, is of considerably greater diameter than the remaining posterior part, which consists of a large and inconstant number of very short segments of similar structure. This division gradually becomes more definitely established, and at the same time the gills make their appearance a simple thin-walled outgrowth of the body-wall, which gradually become branched in a more and more complex manner. There are thus formed eleven pairs of these structures, situated in segments 8 to 18 inclusive and containing looped blood-vessels derived from the main vascular trunks. The nephridea are already visible through the transparent body-wall, as six pairs of somewhat elongated sac-like structures situated in segments 5 to 10. The otocysts are now clearly visible; the circulation of the blood, with the contractions of the dorsal vessel and of the two 'hearts,' can be readily seen, as can also the secondary external division of each of the anterior segments into five by superficial circular grooves. At this stage, in fact, apart from this small size (12 to 18 mm.) and complete transparency, the larvæ are in both habits and structure practically identical with the adult.

R. S. LILLIE.

The following papers were also presented during the quarter: 'Caspar Friedrich Wolff

and the *Theoria Generationis*,' Dr. W. M. Wheeler; 'Field Work at Turkey Lake and a Series of Turtle Embryos from that Locality,' Miss E. R. Gregory; 'Recent Literature on Spermatogenesis,' M. F. Guyer; 'Eisig on the Development of the Capitellids,' Dr. C. M. Child; 'Early History of the Optic Vesicles and Accessory, Eye-like Vesicles in Vertebrates,' Dr. W. A. Locy, of Northwestern University; 'Characteristic Features of Mitosis and Amitosis,' Dr. S. Watasé; 'The Field Columbian Museum Expedition to Africa in 1896,' Dr. D. G. Elliott, Director of the Expedition; 'Protective Coloration,' Dr. W. H. Dudley.

DISCUSSION AND CORRESPONDENCE.

THE STORING OF PAMPHLETS.

A CHEAPER grade of pamphlet box than those described by Dr. Minot can be obtained, made of pasteboard instead of light wood. They are strong enough for ordinary service. Those which I use were obtained at a local bindery, not made to order, but kept in stock, and measures 11 x 7 x 3 inches. They are open at the back; the front face, 11 x 3, is covered with black cloth, to which a label is easily attached.

For pamphlets of quarto size, too large to get in these boxes, and not taking kindly to a vertical position, I have procured covers with pasteboard sides and a partly flexible back. The two sides measure each 12 x 10 inches, and the back, attached to 12-inch edges, is 3 inches wide. The outside is of black cloth, two thicknesses of which make the flexible part of the back. A strip of pasteboard one-inch wide gives stiffness to the middle of the back and a place for the label. When first put into service a sufficient number of pamphlets must be put in each cover to fill one inch in depth. The flexible part of the back, one inch on either side of the pasteboard strip, will allow an expansion of two inches before the contents require reassorting. The covers may be placed one upon another on the shelves, arranged in groups of subjects. These I find very serviceable for the larger pamphlets.

WINSLOW UPTON.

BROWN UNIVERSITY,

January 28, 1899.

NOTES ON INORGANIC CHEMISTRY.

SEVERAL months ago M. and Mme. Curie separated from pitch blende a strongly radio-active substance for which they proposed the name *polonium*. In the *Comptes Rendus* for December 28th, in conjunction with M. Bémont, they describe another supposedly new element in pitch blende for which they propose the name *radium*, while the elementary character of polonium is confirmed. Polonium in its chemical nature seems to resemble bismuth, while radium is analytically indistinguishable from barium. Indeed, it would appear, especially as the spectrum of the new substance is apparently identical with that of barium, except one line, that in their samples radium is present only in small proportion and as an impurity in barium. The claim that it is a new element is based upon the radio-activity of the substance. Barium is not radio-active, while the substance obtained from pitch blende is extremely radio-active. By solution of the chlorid in water and precipitation with alcohol the substance may be fractioned until the chlorid is 200 times more active than uranium. In the spectrum of this substance Demarcy finds a line whose wave-length is 3814.8, and which is not due to any known substance. The further the chlorid is fractioned the stronger this line appears. An atomic weight determination showed a variation from that of barium only within the limits of experimental error.

In the January number of the *American Chemical Journal* the work of E. C. Franklin and C. A. Kraus on liquid ammonia (already noticed in this JOURNAL) is continued. Since many inorganic salts are soluble in liquid ammonia, the probability of metathetic reactions, analogous to those in water, would be great. Such the authors find actually take place. Using the nitrates of sixteen metals, and the sulfid, chlorid, bromid, iodid, chromate and borate of ammonium as precipitant, it is found that those salts which are insoluble in ammonia are readily precipitated. The reactions with ammonium sulfid present the most interest, as the compounds formed differ in many cases at least from those formed in aqueous solution, as is

evidenced by their color; for example, that with cobalt is pink, with nickel and with cadmium, white. The cobalt and the cadmium compound assume the normal color of the sulfid on adding water. These seem to be complex compounds, as the precipitate from magnesium nitrate with ammonium sulfid was examined and found to correspond best to the formula $2\text{MgS}, (\text{NH}_4)_x\text{S}$, $x\text{NH}_3$, where x is 9 or 10.

CONSIDERING in a second paper some of the properties in liquid ammonia the authors show its close relation to water. As a solvent for salts it is only surpassed by water; it closely approaches water in its power of dissociating electrolytes; indeed, some salts conduct electricity better in ammonia solution than in aqueous solution; in many compounds it plays the same part as water of crystallization; its specific heat is as great as that of water and its molecular elevation constant is lower than that of any other substance yet measured. As a solvent it differs from water in not dissolving the sulfates and sulfitates, the alkaline carbonates, phosphates and oxalates, and hydroxids. In its solvent power for organic substances it comes nearer alcohol than water. The solid ammonia is not, like water, specifically lighter than the liquid, nor does it exhibit a maximum density above its melting point. Altogether, the investigations which Professor Franklin is carrying out on liquid ammonia promise to enrich our chemical knowledge in no small degree.

J. L. H.

CURRENT NOTES ON ANTHROPOLOGY.

BAD FORM IN ANTHROPOLOGICAL WRITINGS.

In a note to one of his recent articles Dr. S. R. Steinmetz criticises, with just severity, two faults conspicuous in some writers on anthropology (though surely not peculiar to works in this branch). The one is the appropriation, without any or sufficient acknowledgment, of the work of others. This may arise from inadequate preparation, an ignorance of what others have written, or a half-knowledge of it, as well as from deliberate intent.

The second fault is constant self-repetition and self-reference. I can name a writer whose references to his own writings exceed those to

all other authors combined. Whether this is vanity, or simply because he does not read the works of others, may be left an open question.

An author who omits references to what his predecessors have accomplished should be read with constant suspicion and distrust.

THE MANGYANS OF MINDORO.

THOSE who have read Professor D. C. Worcester's account of the Mangyans of the Island of Mindoro, in the Philippines, which he contributed to the *National Geographic Magazine* (1898, No. 6), must have finished his article with the impression that these were about the lowest savages belonging to the human species.

Professor Worcester, however, does not mention the remarkable and redeeming fact that these people are literary; that they have and have had, so long as they have been known, a phonetic alphabet and written records. I have a copy of a document in this alphabet before me, given in the appendix to Paterno's work, 'Los Itas' (Madrid, 1890); and in 1895 Dr. Foy published a study of it, with numerous examples, in the 'Abhandlungen' of the Ethnographic Museum of Dresden. A brief article on the subject, by the eminent specialist, Professor Blumentritt, may be found in *Globus*, March, 1896 (No. 11). We cannot place such a people in the status of savagery.

THE JEW AND THE GYPSY.

UNDER the above promising title, Mr. W. H. Wilkins edits a volume of the literary remains of Sir Richard F. Burton (H. F. Stone & Co., Chicago). Nearly 300 pages are devoted to these two wandering peoples. The reader who expects new and entertaining facts from Burton's wide experience will be disappointed. The essay on the Jew contains nothing that has not appeared elsewhere, and that on the Gypsy is largely taken up with an ancient and barren controversy. The only portion of the former article which contained original observations the editor thought fit to suppress.

Burton's work in ethnology, though varied and abundant, was superficial and prejudiced. He was not thorough, and his enthusiasm, for and against, led him repeatedly to adopt and defend untenable opinions. Probably the most

carefully studied work of his life was that which his widow burned immediately after his death.

D. G. BRINTON.

UNIVERSITY OF PENNSYLVANIA.

AGRICULTURAL EDUCATION IN RUSSIA.

THE forthcoming number of the *Experiment Station Record* describes the plans of the government of Russia for the establishment of a system of agricultural education. At a recent meeting of the Agricultural Council, an advisory body, of which the Minister of Agriculture is Chairman, an outline presented by the Minister was considered at length and a general plan of agricultural education was elaborated. The introductory to this document states that notwithstanding the fundamental importance of agriculture to Russia and the great fertility of some of the Russian soils, "the crops obtained even on the black soil are only one-third to one-half as large as those harvested from the incomparably inferior soils of western Europe. Almost everywhere in Russia the primitive processes of farming are persistently followed by the farmers, while the number of persons who are fitted by education and training to disseminate information on the rational methods of agriculture is comparatively insignificant." The scheme is outlined for (1) higher education, furnished by independent agricultural institutes located in the chief agricultural zones of Russia, and by chairs of agriculture and allied sciences in the universities; (2) agricultural high schools, which are in the nature of technical schools and schools with courses in agriculture; (3) lower agricultural schools; and (4) the diffusion of general agricultural information. The schools for the so-called lower education include (a) secondary agricultural schools, (b) primary agricultural schools, (c) agricultural classes, and (d) practical agricultural courses. These lower schools are to be under the jurisdiction of the Minister of Agricultural and Imperial Domains. They are to be maintained at the expense of municipalities, local communities, associations, etc., but may receive a part of their support from the government. They are to have the franking privilege for official mail matter and packages not exceeding 36 pounds in weight. The secondary schools are to be established on

government land or land donated for that purpose. The other lower agricultural schools may be established on private estates. The secondary schools are open to young men of all conditions who have completed the course in the primary public schools. The course of instruction covers four years, and includes in addition to the general studies the elements of the natural sciences, agricultural and rural economy, cattle raising, veterinary, agricultural law, horticulture, gardening, etc., together with carpentry and blacksmithing in their application to agricultural machinery. The primary agricultural schools are open to all who can read and write and have a knowledge of arithmetic as far as fractions. The courses last from one to three years. They include, aside from general studies, instruction in the elements of agriculture, with practical exercises. The classes in agriculture are intended for the instruction of young men of the peasant class. The course does not last longer than two years, and consists in the study of the rudimentary principles of agriculture and their application to the local conditions. The successful completion of the course in these three grades of the lower agricultural schools carries with it certain reductions in the military requirement, dependent upon the grade. The practical agricultural courses are designed to impart popular information in particular branches of agriculture. The instruction does not continue for more than a year, and consists in demonstrations, talks and practical exercises in different branches of agriculture in their application to local conditions, and especially to the conditions of the peasants. The diffusion of general agricultural information is to be provided for by: (1) the organization of public readings or lectures on agricultural questions for the benefit of different classes of the population; (2) instruction of the teachers in the public schools in agriculture, horticulture, gardening, apiculture, etc., and providing the public schools with small plots of land and means for cultivating the same; (3) the teaching of agriculture in the normal schools, and (4) the introduction of supplementary courses in agriculture in the village schools. There are now in Russia 3 schools for higher agricultural instruction, 9 agricultural high schools, 83 lower

schools and 59 special courses. Steps have already been taken for the establishment of about 50 additional agricultural schools.

THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.

THROUGH the courtesy of the Secretaries of the Royal Society, we have received a copy of the *Acta* of the Second International Conference on a Catalogue of Scientific Literature, together with the report of the committee of the Royal Society, with schedules of classification, and hope to give full consideration to a subject which is probably the most important now before men of science. It is to be hoped that the verbatim report of the proceedings of the second conference will be printed promptly and freely distributed among men of science and scientific journals. This is especially important in view of the short time, now less than one year before the plans of the Conference are to be put into effect. In connection with this subject we quote the following editorial note from the last number of *Natural Science*:

"In our last number we gave a short account of the proceedings at the International Conference on Scientific Literature convened by the Royal Society. We did not think it necessary to say that we had abstracted this account from our highly valued contemporary *Nature*, since we assumed that the *procès-verbaux* were public property, and that copies would be distributed to the press, especially the scientific press, in due course. No copy has yet reached us, and we gather from SCIENCE, as well as from other sources, that no attempt has been made by the Royal Society to furnish the scientific public with any account of the work carried on by this Congress. We now recall the strange fact that the elaborate 'Report of the Committee of the Royal Society of London, with Schedules of Classification,' though bearing date March 30, 1898, was never heard of by many of those most interested until late on in the year (*vide* articles in SCIENCE, and by Professor Victor Carus in *Zoologischer Anzeiger*). It seems to us that the Royal Society does not realize its responsibilities. Why this shrinking from the public gaze? Are the members of the committees so afraid of criticism? This is a scheme

that appeals to the whole world of science ; it will have to be supported by money ; it will require the ardent cooperation of numerous individuals. To say the very least, it is not wise of the Royal Society to put on its usual airs of superiority and indifference in a matter of this kind. We have excellent reason for believing that the eminent and courteous Secretaries of the Royal Society are not responsible for this darkness where there should be light. Who, then, is the culprit ?"

SCIENTIFIC NOTES AND NEWS.

MRS. ESTHER HERRMAN has given \$10,000 to the building fund of the Scientific Alliance of New York City. It will be remembered that about a year ago we gave an account of the plans for erecting a building for the different scientific societies of New York. Such a scientific center is greatly needed, and it is to be hoped that Mrs. Esther Herrman's generous gift will be followed by others.

MR. EDWARD E. AYER has resigned the presidency of the Field Columbian Museum, Chicago. A successor has not yet been elected.

PROFESSOR A. E. TÖRNEBOHM has been elected President of the Swedish Geological Society for 1899.

MR. W. ANDERSON, of the Geological Survey of India, has been appointed director of a survey of Natal about to be undertaken by the Colony.

THE Academy of Science of St. Petersburg has elected as honorary members the King of Sweden, the Queen of Roumania, Fridjof Nansen and M. Émile Sénart, member of the Institute of France.

M. A. LOREAU, President in 1898 of the French Society of Civil Engineers, and Count A. de Dax, Secretary of the Society, have been made by the Emperor of Russia a commander and a knight, respectively, of the order of St. Stanislas.

MR. R. T. BAKER has been made Curator of the Technological Museum of Sydney, N. S. W.

THE death is announced of Dr. Dumontpallier, an eminent Paris physician and an author of contributions to pathology, especially of the nervous system, at the age of 74 years ; and of

Lieut.-Col. Robert Pringle, M.D., of the British army, the author of numerous papers on the hygiene and diseases of India.

WE learn from the *Botanical Gazette* of the deaths of three foreign botanists, M. F. Gay, of the University of Montpellier, at the age of 40 years, a student of the green algæ, Pastor Christian Kaurin, of Sande Jarlsberg, Norway, at the age of 66, a well-known student of Scandinavian bryology, and Professor T. Carnel, professor of botany and director of the botanic garden at Florence.

THE *London Times* gives the following details concerning the Rev. Bartholomew Price, F.R.S., whose death we recently recorded : Born at Cole St. Dennis, Gloucestershire, in 1818, Mr. Price was educated privately and at Pembroke College, whence he obtained a first class in mathematics in 1840. He gained the University Mathematical Scholarship in 1842, and two years later was elected Fellow of his College. In 1844 he became tutor and ten years afterwards Sedleian professor of natural philosophy. In 1852 appeared the first volume of his elaborate work on the infinitesimal calculus ; the last of the four was not published till ten years later. This book obtained for him a considerable reputation in the mathematical world ; but his principal work in life was practical, and he will be remembered rather as the active Secretary of the University Press during the years of its first great activities after the death of Dean Gaisford, than as a mathematical professor. Bartholomew Price was a keen yet cautious man of business, and in his best days did much for the interests of the University both at the Press and as member of the Hebdomadal Council. Probably nobody of his time filled the latter post during so many years as he, or was so often called upon to be the spokesman of the Council in proposing new statutes and decrees to Congregation.

WE learn from *Natural Science* that at a meeting in Edinburgh, on November 8th, a committee was appointed to consider the feasibility of establishing a Scottish Zoological Garden. "The idea of a 'Zoological Society' was mooted, but did not, we are pleased to learn, find support. There are already three or four societies

in Edinburgh which have to do with Zoology, and any attempt to insinuate another would simply alienate the sympathies of those who would be glad to see a well-considered Zoological Garden instituted. A committee, including Professor Cossar Ewart, Dr. Ramsay Traquair, Professor A. E. Mettam, Mr. Fairgrieve, Mr. W. S. Bruce, Mr. Hope Findlay and others, was appointed, and we wish them success. We venture to predict that a successful site is to be found in the direction where holidayers do most resort. Proximity to the sea would also be a great advantage. We hope the enthusiasts and the capitalists may come to terms, and that more may soon be heard of this excellent scheme."

At the recent annual meeting of the New York Academy of Medicine both the retiring President, Dr. E. G. Janeway, and the incoming President, Dr. William H. Thomson, advocated the establishment of a research laboratory in connection with the Academy. The library of the Academy now contains 70,360 books, being one of the most extensive medical libraries in the world.

THE Chelsea Physics Garden, established in 1721 by Sir Hans Sloan, at present forms the site of the garden and buildings of the Society of Apothecaries, occupied by them at a nominal rent of £5, on condition that the garden be maintained for the purpose of botanical and medicinal study, and supply the Royal Society with specimens of fresh plants every year. The Society wishing to be relieved of the trust, the London County Council has drawn up a plan for its further maintenance. The scheme provides that the City Parochial Foundation, which is prepared to make a grant of a capital sum and a *maximum* yearly amount of £800 for maintenance, shall be the trustees. It is proposed to provide a museum, a lecture theatre, a botanical laboratory and a biological laboratory, partly in the existing buildings and partly in new buildings, which, it is anticipated, will encroach on the garden to the extent of only one-eighth of an acre. The trust is to be administered by the trustees and by a committee of management that will include representatives from the Royal Society, the Royal College of

Physicians and other institutions. Provision is made for the appointment of a Curator and other officers.

THE New England Association of Chemistry Teachers held their first annual meeting at Boston on January 28th. The following officers were elected: President, Dr. Lyman C. Newell; Vice-President, Rufus P. Williams, of Boston; Secretary, M. A. Stone, Watertown; Treasurer, E. F. Holden, Charlestown; Executive Committee, William H. Snyder, Worcester, Miss Delia M. Stickney, Cambridge, and Charles R. Allen, of New Bedford. The Association now numbers 49 members.

THE centennial anniversary of the Medical and Chirurgical Faculty of Maryland will be celebrated in Baltimore, April 25th, 26th and 27th.

A NUMBER of cases of bubonic plague have occurred on the Island of Mauritius.

DR. CARL PETERS has left London with a well-equipped expedition to explore the African territory south of the Zambesi River with a special view to the discovery of gold.

Natural Science states that Sven Hedin is classifying his geological specimens, which he will present to the High School of Stockholm, and is preparing a detailed account of his journey from Kathgar to Khotam for *Petermann's Mittheilungen*. His archæological collection and manuscripts will be arranged by Professor Grunwedel and exhibited in the Berlin Museum, whilst Dr. Ekholm is dealing with the meteorological notes. The maps and charts, covering 552 sheets, have been confided for enlargement and reproduction to Justus Perthes, of Gotha. Dr. Hedin proposes to start on his next journey of Asian exploration about the middle of 1899. He intends to cross the Taklamakan desert twice, thoroughly explore one of the largest rivers of Turkestan, and again study the interesting Lob Nor problem. The most important part of the work will, however, be explorations in the north and interior parts of Tibet. Dr. Hedin hopes to be able to spend a winter in some of the highest alpine regions of Tibet at a height of about 15,000 feet. Then he will pay a visit to the new Viceroy of India, and will return over Himalaya, Karakoram and Kashgar. Dr. Hedin will again go alone, and

he calculates that his three years' travel will cost no more than £2,500.

It is proposed to establish in University College, Liverpool, a class for students who will devote themselves to the investigation of tropical diseases, to which end a special lecturer will be appointed, and the students will have the advantage of watching cases and their treatment in the Royal Southern Hospital. Mr. A. L. Jones, well known in the West African trade, has offered to contribute £350 a year towards the expenses of the intended special school. A general committee has been formed, which, in conjunction with a committee of the Royal Southern Hospital, will make adequate arrangements for the work in new buildings to be erected for the hospital.

At a meeting of the central committee for establishing sanatoria for consumptives on January 9th, says the *London Times*, it was stated in the annual report that there were already 20 sanatoria in Germany for consumptive patients. Regret was expressed that accommodation was chiefly provided for male patients, and attention was called to the urgent necessity of establishing sanatoria for women. A committee of ladies under the presidency of Princess Elizabeth zu Hohenlohe had carried on a good work in providing for the families of those who, as patients in the sanatoria, were debarred from earning their living. A large number of towns and also of provincial districts throughout the Empire had, through their representatives, given their adhesion to the central committee, which now numbered 466 members. At the close of the year 1898 the funds amounted to 250,000 Marks. A sum of 224,500 Marks had already been devoted to subsidizing new sanatoria, and 70,000 Marks had been promised for the same purpose. The Duke of Ratibor, the nephew of the Chancellor, made a statement regarding the congress on tuberculosis, its dangers and its prevention, which will meet in Berlin at Whitsuntide under his presidency. Invitations to attend this congress will be addressed to foreign countries. Professor von Leyden spoke on the same subject and expressed a hope that the congress would contribute to make the success of the national

movement for combating tuberculosis in Germany more widely known and that it would secure fresh supporters for this work of humanity.

CONSUL-GENERAL GOWDY, of Paris, in his annual report, says that during the past year there has been a marked increase in the adoption of automobiles, not only as pleasure vehicles, but for practical application in the way of cabs serving the public in the city of Paris, and for business purposes in the way of delivery wagons, especially those for long distances. It is announced that at the beginning of next year there are to be 100 motor cars driven by electric power running in the streets of Paris, and, if the experiment be successful, the cabs will be increased to 1,000. With this project in view, a large plot of ground has been acquired, where the building of works necessary for the housing of the cabs and the machinery for the electric supply are being rapidly completed. A training ground has also been made for the cabmen. This is laid out with every possible form of paving, wood, asphalt, stone, etc., including two steep hills. Here and there are dotted about a number of dummy figures, and in and out of these the cabmen have to maneuver, under the orders of an instructor. As a rule, in four lessons, it is stated, the driver is ready to navigate Paris and after ten lessons is considered thoroughly competent. Each cab is supplied with sufficient power to be driven 30 miles at about 8 miles an hour.

THE *London Times* states that Dr. Ferras, who has been in practice in Calcutta since 1853, in his evidence before the Plague Commission, on January 4th, expressed the opinion that there had never been plague cases in Calcutta, but simply cases of malignant fever. He remembered seeing similar cases when a student in Calcutta which were indistinguishable from plague except bacteriologically. There had been no bacteriological experts in India since the time of Dr. Cunningham. Unless Calcutta was improved structurally and the *bustis* were cleared and the overcrowded areas opened out, there was no chance that malignant fever would disappear. Captain Bingley, who had been employed on plague duty in Bombay, recommended municipi-

pal camps as a remedy for overcrowding. They had been tried at Bombay, but were not successful, as they were started too late. A camp in his own district was very successful. The people willingly paid two rupees a month, which covered the expenses and paid the interest. The plague increased after the season of the export of grain, because the rats then left the *bandars* and spread through the town in their search of food, carrying the infection with them. The *bandars* were the foci of the plague. Mr. Griesbach, Director of the Geological Survey of India, gave evidence as to the formation of the soil in the infected areas which pointed to the trap and crystalline area being specially adapted to the spread of the disease, but the witness explained that Bombay was situated near the center of the Deccan trap formation. On the alarm of the plague the people naturally spread fanlike over the adjoining country. There was abundant evidence that the tenacity with which epidemics clung to localities was influenced by the geological formation.

THE University of the State of New York announces that one of the most important of the twenty-two bulletins issued by the museum is sent to the schools this month. This is a large octavo of 156 pages, entitled a 'Guide to the study of the geologic collections of the New York State Museum,' by Dr. Frederick J. H. Merrill, Director. In the front pocket is a folded relief map showing the boundaries of the geologic systems on a scale of twenty-four miles to an inch, and the entire volume is profusely illustrated with half-tone photographs of geologic features. The general plan is such that it will serve as a guide to any other geologic collections in New York, and will also be useful to teachers in New York secondary schools who wish to direct the attention of their students to local geology. It gives briefly a digest of the New York geologic reports, with much useful introductory matter, and is meant, not in any sense to replace the small text-books, but to supplement them by giving information found as a rule only either in the larger and more expensive books which are not accessible to most teachers and students, or in a multitude of scientific papers.

FROM a Blue Book on the Straits Settlements *Nature* learns that the Perak Museum at Taiping is now overcrowded, and that there is consequently much difficulty in arranging the collections in their natural sequence, while there is practically no room for new specimens. The Taiping collections are specially rich in the ethnological and mineralogical branches, and the zoological specimens have recently been greatly improved. The photographic and botanical branches were extended during the year, and the museum now contains a valuable section allotted to economic botany. Investigations were carried out, with satisfactory results, on the subject of insects attacking coffee, rice and other agricultural products, and some experiments were made in connection with tapping rubber. Discussion has been going on as to constituting the museum at Taiping a central museum, supported by all the Federated Malay States. The curator at Taiping suggests that local museums, of which one has been in existence for several years at Selangor, and which, it is hoped, will soon be established in the other States, might either be affiliated to, or form branches of, the Federal Museum. On the other hand, the British Resident at Selangor urges that the existence of a local museum creates and sustains in the minds of the community an interest in local products, their sources and uses, which cannot fail to be beneficial and deserving of encouragement, and it cannot be urged that people in Selangor or the Negri Sembalin will obtain any advantage from a museum in Perak, however complete, which few of them will probably ever see.

IN the museum of the Royal Agriculture and Commercial Society of British Guiana at Demerara, says *Natural Science*, various changes have recently been introduced. The exhibited series of birds has been revised according to the British Museum catalogue, and over 200 specimens have been remounted. Other groups have been partially revised, so far as is possible in the absence of modern literature. It is hoped that the issue of a revised edition of the British Museum Catalogue of Fishes will enable the Curator to work up those animals as completely as the birds; meanwhile a comprehensive collection of British Guiana fishes is

being made, and preserved for the most part in formalin. Exhibition space in this museum has been extended by the addition of an upper gallery. Chief among recent acquisitions is a large series of rocks collected in the Northwest District by J. B. Harrison and H. I. Perkins, to illustrate a government report. The chief difficulty in the curatorial work of this museum is presented by atmospheric changes and over much moisture. It is satisfactory to learn that many inquiries are made at the museum, both personally and by correspondence, and that it is becoming more and more a general educating force in the colony.

UNIVERSITY AND EDUCATIONAL NEWS.

At the annual meeting of the Board of Regents of the Smithsonian Institution, held in Washington on January 25th, an inquiry was raised as to the propriety and expediency of taking action toward the establishment of a national university, and a committee was appointed to investigate and report at the next meeting. The committee is: John B. Henderson, of Washington; Alexander Graham Bell, of Washington; William L. Wilson, of Virginia (the three members of the Executive Committee of the Board of Regents); James B. Angell, of Michigan, and Robert R. Hitt, of Illinois.

COLUMBIA University is making plans to establish a summer school during and after the summer of 1900. The courses, as is usual in summer schools, will be planned with special reference to the needs of teachers, and the resources of the Teachers College will be fully utilized.

THE Cornell Medical College proposes to establish a summer school of medicine to be given in New York hospitals and dispensaries.

THE State University of Iowa announces a course of lectures on the Elements of Anthropology, to be delivered early in March by W. J. McGee, Ethnologist in charge, Bureau of American Ethnology.

DR. E. B. MCGILVARY, of the University of California, has been called to the Sage professorship of moral philosophy at Cornell University, vacant by the removal of Professor Seth to the University of Edinburgh.

PROFESSOR C. A. KEFFER, of the Division of Forestry, Department of Agriculture, has been elected professor of agriculture and horticulture in the New Mexico Agricultural College.

MR. J. S. E. TOWNSEND, B.A., of Trinity College, Cambridge, has been elected to the Clerk Maxwell scholarship.

DR. G. MEYER, till now first assistant in the Physical Institute, has been elected to an assistant professorship of physical chemistry in the University of Freiburg. Dr. Zehnder, assistant professor of physics at Freiburg, in Br., has been called to Würzburg as first assistant to Professor Röntgen. Dr. Otto Wiedeburg, docent in physics in the University at Leipzig, has been promoted to an assistant professorship. Dr. Sidler, assistant professor of astronomy at Berne, has been given an honorary professorship. In the Faculty of Science at Nancy the following changes have been made: M. Floquet, professor of pure mathematics, has been made professor of analytical mathematics; M. Molk, professor of applied mathematics, has been made professor of mechanics; M. Haller, professor of chemistry, is professor of organic chemistry, and M. Güntz has been appointed professor of mineralogical chemistry.

Two of the more important chairs at Oxford are vacant—the Sedleian professorship of natural philosophy, so long filled by the late Dr. Bartholomew Price, and the Linacre professorship of comparative anatomy, vacant by the removal of Professor Ray Lankester to the British Museum. *Natural Science* reports that the past students of Professor W. F. R. Weldon, of University College, London, are signing a testimonial to their former teacher in view of his candidature for the latter chair. Among others whose names are mentioned as candidates are Mr. F. E. Beddard, prosector to the Zoological Society of London; Mr. G. C. Bourne, who for many years has been demonstrator and lecturer at Oxford; and Mr. W. Baldwin Spencer, formerly demonstrator to Professor Moseley and now professor of zoology at Melbourne. The last mentioned is now visiting Great Britain. The method of filling chairs at Oxford is not above criticism. On the board appointing a successor to Professor Lankester theology and medicine are well represented, but not natural science.

SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; J. LE CONTE, Geology; W. M. DAVIS, Physiography; O. C. MARSH, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; HENRY F. OSBORN, General Biology; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; J. McKEEN CATTELL, Psychology; DANIEL G. BRINTON, J. W. POWELL, Anthropology.

FRIDAY, FEBRUARY 10, 1899.

CONTENTS:

<i>The Smithsonian Institution</i>	193
<i>Agricultural Experiment Stations</i> : DR. A. C. TRUE.....	199
<i>Physiological Osmosis</i> : PROFESSOR GEORGE MAC- LOSKE.....	206
<i>Professional Schools vs. Business</i> : PROFESSOR R. H. THURSTON.....	207
<i>Mechanical Illustration of Kirchhoff's Principle</i> : PROFESSOR WILLIAM HALLOCK.....	210
<i>Plastiline, a New Modeling Compound</i> : DR. C. R. EASTMAN.....	211
Scientific Books:—	
<i>Beddard on the Structure and Classification of Birds</i> : F. A. LUCAS. <i>Russell on The Rivers of North America</i> : PROFESSOR R. E. DODGE. <i>Broomell's Anatomy and Histology of the Mouth and Teeth</i> : PROFESSOR CHARLES S. MINOT. <i>Books Received</i>	212
<i>Scientific Journals and Articles</i>	217
Societies and Academies:—	
<i>The Texas Academy of Sciences</i> : PROFESSOR FREDERIC W. SIMONDS. <i>Philosophical Society of Washington</i> : E. D. PRESTON. <i>The Anthro- pological Society of Washington</i> . DR. J. H. MC- CORMICK. <i>The New York Academy of Sciences, Section of Psych-ology and Anthropology</i> : DR. C. B. BLISS. <i>Section of Astronomy and Physics</i> : DR. REGINALD GORDON. <i>Academy of Science of St. Louis</i> : PROFESSOR WILLIAM TRELEASE.....	217
Discussion and Correspondence:—	
<i>Zoological Nomenclature</i> : DR. W. H. DALL. <i>The Red Beds of Kansas</i> : PROFESSOR S. W. WILLISTON. <i>Men of Science and Anti-vivisection</i> : HENRY C. MERCER.....	221
Astronomical Notes:—	
<i>Reports of Observatories; The Planet DQ</i> : PRO- FESSOR WINSLOW UPTON.....	224
Notes on Physics:	
<i>Some Recent Investigations upon the Becquerel Rays</i> : A. ST. C. D.....	225
Botanical Notes:—	
<i>Sargent's Silva of North America; Commendable Free-Seed Distribution; The Study of Iowa Sedges; North American Seaweeds; Arthur and Holway's Rusts</i> : PROFESSOR CHARLES E. BESSEY.....	226
Current Notes on Anthropology:—	
<i>Courses at the Ecole d'Anthropologie; The Mean- ing of Race; The Extinction of the Polynesian</i> : PROFESSOR D. G. BRINTON.....	227

<i>Meeting of the Trustees of the Marine Biological Laboratory</i>	228
<i>Scientific Notes and News</i>	228
<i>University and Educational News</i>	232

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

THE SMITHSONIAN INSTITUTION.*

FINANCES.

The permanent funds of the Institution are as follows:

Bequest of Smithsonian, 1846.....	\$515,169.00
Residuary legacy of Smithsonian, 1867..	28,210.63
Deposits from savings of income, 1867	108,620.37
Bequest of James Hamil- ton, 1875.....	\$1,000.00
Accumulated interest on Hamilton fund, 1895. ...	1,000.00
	2,000.00
Bequest of Simeon Habel, 1880.....	500.00
Deposits from proceeds of sale of bonds, 1881.....	51,500.00
Gift of Thomas G. Hodgkins, 1891...	200,000.00
Portion of residuary legacy, T. G. Hodgkins, 1894...	8,000.00
Total permanent fund.....	912,000.00

The appropriations made by Congress for the fiscal year 1899 were as follows:

International Exchanges, Smithsonian Institution, 1899.....	\$21,000
American Ethnology, Smithsonian In- stitution, 1899.....	50,000
Astrophysical Observatory, Smithsonian Institution, 1899.....	10,000
National Museum, Smithsonian Institu- tion, 1899:	
Furniture and fixtures.....	35,000
Heating and lighting.....	14,000

* From the report of S. P. Langley, Secretary of the Smithsonian Institution, for the year ending June 30, 1898.

Preservation of collections	165,000
Postage	500
Galleries	10,000
Books	2,000
Rent of workshops	4,500
Building repairs	4,000
Purchase of library of the late G. Brown Goode	5,000
National Zoological Park, 1899	65,000

HAMILTON FUND.

The original amount of \$1,000, the bequest of Mr. James Hamilton, of Pennsylvania, received by the Institution in 1874, was increased in 1895 to \$2,000 by the addition of accumulated interest under authority given by the Regents in their meeting of January 23, 1895, the sum of \$150 expended from the income of fund in 1876 for explorations having been refunded. The present income, together with interest accumulated since 1895, seems to warrant some definite application of the interest on the bequest, and I am now considering a plan of lectureships in accordance with the testator's purpose.

AVERY FUND.

Concerning the Avery fund I have to report that by a decision of the Supreme Court of the United States the Institution has obtained a clear title to the property on Capitol Hill claimed by the heirs of Mrs. Avery.

It may be recalled that the testator, while leaving his property absolutely at the disposal of the Regents, expressed a wish that it might be made useful in promoting researches on the Ether, after certain mathematical and phonetic publications and certain researches connected with a special form of telescope have been made. The moneys received from the estate are as yet too small to carry out any part of this purpose but the last.

BUILDINGS.

No alterations were made in the Smith-

sonian Building during the year except such slight repairs as seemed necessary to keep it in good condition. The space in the rear of the building, however, which for a number of years had been occupied by unsightly and dangerous storage sheds and workshops, has been cleared of these and graded into a lawn, thus greatly improving the surroundings.

In the park south of the building, and at a distance sufficient to prevent annoyance, there has been erected a temporary wooden building of two stories for the use of the taxidermists and for other purposes.

The investigations being prosecuted in the Astrophysical Observatory requiring more space than is available in the old structure, plans have been approved and some progress made toward the erection of some very simple additions authorized by Congress at its last session by a clause permitting the expenditure for this purpose of an unexpended balance.

Four additional galleries have been erected in the Museum building, three for exhibition purposes and one to serve as an increase for the quarters for the Library, thus adding 6,650 square feet to the floor space of the Museum, 6,040 square feet of which is available research for exhibition purposes.

The promotion of original research has always been one of the principal functions of the Institution. Investigations in the anthropological, biological and geological divisions of science have been extensively carried on through the departments of the National Museum, and in the Bureau of American Ethnology there have also been special inquiries into Indian customs and languages. These lines of research being well represented by its bureaus, it has remained for the Institution proper to devote its energies more especially to some of the physical sciences.

The Secretary himself has carried on re-

searches in the solar spectrum, which, by the active assistance of the aid in charge, have produced results now shortly to be published. They are believed to be important and are referred to in another portion of this report.

The Secretary has not wholly discontinued the studies which he has made in regard to aerodromic experiments, and it is perhaps not improper that he should state that these have attracted the attention of other departments so far that during the war with Spain a commission was directed by the Secretaries of War and the Navy to inquire into them with a view of their possible utility in war. This is not the place to state the results of these inquiries.

The Secretary desires to repeat, however, that his time is almost solely given to administrative work, and that what he has been able to do in these directions has been done largely in hours which he might consider his own.

HODGKINS FUND.

Although the Hodgkins fund competition announced by the Institution in the widely distributed circular of March 31, 1893, was definitely closed so long ago as December 31, 1894, a very general interest is still expressed in the subject, and specialists in our own and other countries not infrequently forward copies of their original published memoirs as contributions to the Hodgkins fund library of the Institution.

Frequent applications for grants are received, and, notwithstanding the fact that the limitations on the use of the fund do not permit it to be employed for the support of an investigation, unless under the exceptional conditions of the first published announcement, it has still been found practicable to approve several awards during the past year.

As noted in my last report, in July, 1897,

an additional grant of \$400 was made to Mr. A. Lawrence Rotch, of the Blue Hill Meteorological Observatory, Readville, Mass., and in the following October a further grant of \$250 was approved to Mr. Rotch. These sums are to be devoted to experiments with automatic kites, for determining, by means of self-recording instruments, meteorological data in atmospheric strata inaccessible except by some mechanical method of exploring the atmosphere, and it will be of possible interest to the Board to learn that during the past year, and (to slightly anticipate), shortly after its close, experiments of remarkable success and interest have been made by Mr. Rotch; and, among others, that kites have been flown to the unprecedented height of 11,086 feet above the station, carrying up with them meteorological instruments which recorded the height, the pressure of the wind, the dew point, and other facts of interest at these great altitudes.

Those who remember the situation at Blue Hill, one of the highest landmarks on the Atlantic coast north of the southern shores of the Gulf, and the aspect of the hills, blue with the distance from which they take their name, may be struck by the certainly notable fact that in these experiments the kites sent up from Blue Hill, and held there at the station, were occasionally directly over the distant ocean.

November 1, 1897, a grant of \$500 was made to Professor William Hallock, of Columbia University, New York City, for an investigation having for its object the complete analysis of a particle of air under the influence of articulate sounds, thus contributing a study of the atmosphere in one of its most important functions, that of a conveyer of speech.

In February, 1898, a final grant of \$250 was made to Drs. Lummer and Pringsheim, of the Physical Institute of the University of Berlin. The investigation begun by

them, in 1893, to determine the ratio of the specific heats, at constant pressure and volume, for air, oxygen, carbon dioxide and hydrogen has now so far progressed that the memoir submitted by Drs. Lummer and Pringsheim, noting the results already attained by them, has been published by the Institution in the *Smithsonian Contributions to Knowledge*.

A German edition of this original memoir, with the consent of the Institution, is to be published by the authors, and it is understood that, if found desirable, their researches will be further prosecuted under the direction of the *Physikalisch-Technische Reichsanstalt*, of Berlin, Professor Dr. Kohlrausch, the President, having courteously signified the readiness of that institution to furnish the means necessary for the purpose.

In February, 1898, an additional grant was made to Mr. E. C. C. Baly, of University College, London, to enable him to continue his research upon the decomposition of the atmosphere by electricity and upon the ozonizing of mercury. The report of Mr. Baly stating the result of these investigations is now awaited by the Institution.

A grant of \$250 to Professor Arthur G. Webster, of Clark University, Worcester, Mass., was approved in May, 1898, for the continuation of a research on the properties of air in connection with the propagation of sound, special effort being directed to the securing of data relating to the influence of the viscosity of air on expiring or vanishing sounds. An instrument devised by Professor Webster for use in this investigation gives the physical measure of sound, not only when constant, but when rapidly varying. It is expected that this research will furnish results of high practical value in connection with the question of the acoustics of auditoriums, and will contribute information upon points that have not heretofore been satisfactorily investigated.

A paper embodying the results of the interesting research, described in the Secretary's report for 1894, primarily conducted under a grant from the Hodgkins fund to Dr. J. S. Billings and Dr. S. Weir Mitchell, and continued, under their supervision, by Dr. D. H. Bergey, of the Laboratory of Hygiene, University of Pennsylvania, has been published in the *Smithsonian Miscellaneous Collections*.

NAPLES TABLE.

Among the applications for the occupancy of the Smithsonian seat at the Naples table during the years 1897-98, the following have been favorably acted upon :

Dr. Bradley M. Martin, of the University of Chicago, whose work has been chiefly in the field of the algæ, and who has published several papers detailing his researches, was appointed for November, 1897, his period at Naples to be supplemented by additional investigation in the laboratory of Dr. Strasburger, of the University at Bonn.

Dr. H. W. Conn, of the department of biology, Wesleyan University, received the appointment for six weeks early in the year 1898; Dr. Dohrn, the Superintendent of the station, kindly arranging for his accommodation, although the Smithsonian table was occupied at that time. The fact that Dr. Dohrn finds himself not only willing, but able, to provide for two or, as in this case, even three students at the Smithsonian table during the same period is a courtesy much appreciated by the Institution.

Dr. D. M. Mottier, of the State University of Indiana, who wished to supplement his investigations at Bonn and Leipzig by some weeks at Naples, was appointed for the months of March and April, 1898.

Dr. W. T. Swingle, of the United States Department of Agriculture, now honorary custodian of algæ in the United States National Museum, occupied the Smithsonian

seat at Naples for an additional month during the spring of 1898.

Dr. J. H. Gerould, of Dartmouth College, who prosecuted his investigations in the laboratory of Professor De Lacaze-Duthiers, at Roscoff, Finisterre, France, during the summer, was appointed to the Smithsonian table at Naples for the month of November, 1898.

EXPLORATIONS.

In the plan of organization of the Institution, among examples of objects for which appropriations may be made, are cited:

Explorations in descriptive natural history and geological, magnetical and topographical surveys to collect materials for the formation of a Physical Atlas of the United States.

Ethnological researches, particularly with reference to the different men in North America; also explorations and accurate surveys of the mounds and other remains of the ancient people of our country.*

The first grant made by the Institution for scientific exploration and field research was in 1848 to Spencer F. Baird, of Carlisle, for exploration of the bone caves and the local natural history of southeastern Pennsylvania; and during the half century that has elapsed since the grant to that eminent man, who afterwards became the Secretary of the Institution, every possible encouragement and support has been given to natural history and ethnological explorations in America and throughout the world. The income of the Institution has not permitted the expenditure of large sums for this purpose, but valuable advice and instructions have been freely given to explorers connected with Government and private expeditions, and agents of the Institution have in very many cases participated in these explorations. In recent years a vast amount of such work has been carried on by the bureaus under direction of the Institution, a work made possible by

Congressional appropriations for this purpose.

As soon as there seemed a possibility of acquiring new territories as a result of the present Spanish-American war I began formulating plans for exploring the possible new regions, and in my next estimates to be sent to Congress I expect to ask definitely for appropriations under which exploring parties may be sent to them.

It is hardly necessary to recall the lasting impression that the French Government made through the researches of the corps of savants sent along with the expedition to Egypt. It would seem incumbent upon this Government, not only from practical economic purposes, but as a contribution to the general intelligence of mankind, to institute scientific inquiry as to the natural history, geology, geography, ethnology, archæology and scientific utilities of any new possessions it may acquire. These inquiries should be made coherently and without clashing on the part of the various Government interests involved.

During the present year investigations among the American Indians have been conducted by the Bureau of Ethnology, and several collaborators of the Institution have made natural history explorations.

PUBLICATIONS.

Secretary Henry said: "It is chiefly by the publications of the Institution that its fame is to be spread through the world, and the monument most befitting the name of Smithsonian erected to his memory." From the beginning of the Institution a considerable portion of its annual income has been expended in publishing the Smithsonian Contributions to Knowledge and the Smithsonian Miscellaneous Collections. Through these series, supplemented by the Annual Reports printed at the direct expense of the Government, and the publications of the National Museum, the Bureau

*Smithsonian Report, 1848, pp. 6. 7.

of Ethnology and the American Historical Association, issued under the direction of the Institution, nearly all branches of human knowledge are represented in the works published during the last fifty years, which form a library of nearly 250 volumes, besides several hundred pamphlet reprints of the memoirs and articles contained in the serial volumes.

Contributions to Knowledge.—One new memoir of this series was unpublished during the year, the result of the investigations by Drs. Lummer and Pringsheim, of Charlottenburg, Germany, on the ratio of the specific heats at constant pressure and at constant volume of air, oxygen, carbon dioxide and hydrogen. This research was aided by a grant from the Hodgkins fund of the Smithsonian Institution. After a period of notable advance the kinetic theory of gases seems to have fallen into temporary abeyance, possibly from a fundamentally imperfect understanding of their behavior. Progress in the knowledge of this fundamental nature of gases may reasonably be looked for from interpretative researches on their thermal capacity, and this paper may be considered as a step in this direction. Aside from its exceptional portance in thermodynamics, the heat ratio is of interest as affording a clue to the character of the molecule, and Drs. Lummer and Pringsheim, using a new method, appear to have for the first time reached coincident results on the incoercible gases examined.

The original edition of the Secretary's memoir on 'The Internal Work of the Wind,' published in 1893, having become exhausted, some additional copies have been printed from the stereotype plates, in which a few minor changes have been made.

The Secretary now has in preparation for this series a review of his investigations in aerodynamics, and in particular of experiments in developing the principles and methods of mechanical flight.

Miscellaneous Collections.—In this series five works have been published since my last report. These are a Catalogue of Scientific and Technical Periodicals, by Dr. H. C. Bolton; Catalogue of Pacific Coast Earthquakes, by Professor E. S. Holden; Review and Bibliography of Metallic Carbides, by Professor J. A. Mathews; Bibliography of Metals of the Platinum Group, by Professor J. L. Howe, and a report by Dr. D. H. Bergey on the results of experiments to determine whether impure atmosphere produces a detrimental influence upon the animal organism as shown in greater susceptibility to certain diseases.

There have been also reprinted from the stereotype plates new editions of the Smithsonian Meteorological, Geographical and Physical Tables. A Supplement to the Bibliography of Chemistry, by Dr. H. C. Bolton, containing about 4,000 additional titles, is in hand, and about half of the volume had been printed at the close of the year.

Smithsonian Reports.—The annual reports of the Institution for the year 1896 and 1897 had not been issued at the close of the fiscal year, although the volume for 1896 was in the Government bindery and press-work was in progress on the report for 1897, their completion having been delayed by the imperative need of supplying documents required by Congress for the military departments by reason of the Spanish-American war.

National Museum Publications.—In addition to the Museum volume of the Smithsonian report, two series of publications are issued directly by the Museum, the Proceedings and the Bulletin. Of the first series Volume XIX. was completed in bound form, the separate papers having previously been issued as pamphlets, and seventeen papers comprising Volume XX. were distributed in pamphlet form during the year. A pamphlet containing instruc-

tions for collecting scale insects was published as Part L. of Bulletin 39, and a circular was issued relating to the collection and preservation of the bones and teeth of the Mastodon and Mammoth.

Bureau of Ethnology reports.—The seventeenth report of the Bureau of Ethnology, for the year ending June 30, 1896, was sent to the Public Printer on July 6, 1897, and proof reading was completed before June 30, 1898, but actual presswork has not begun. The eighteenth report is also in the printers' hands, but no progress has been made beyond the revision of some first proofs.

Astrophysical Observatory publications.—There has been prepared and is now ready for publication a full report on the results of the researches carried on in the Astrophysical Observatory since its establishment and this work will probably be printed in quarto form during the next fiscal year, the cost of the publication being charged to the appropriation for the Observatory under authority of Congress.

LIBRARY.

The number of accessions to the library has been greater than at any time heretofore, the total entries of volumes, parts of volumes, pamphlets and charts reaching 40,715, an increase of nearly 5,000 over the previous year. The greater part of this has been sent to the Library of Congress to be placed with the Smithsonian deposit.

The Museum library shows a greatly increased use over last year. The limited quarters assigned for library purposes in the Museum are so greatly crowded that it has become necessary to provide additional book room, for which purpose a gallery directly adjoining the library has been erected and fitted with shelves, where space is provided for 18,000 volumes. This is rendered necessary by the purchase for the Museum, by Congressional appro-

priation, of the scientific library of the late Dr. G. Brown Goode. The Institution is especially fortunate in being able to obtain this library and the Museum now has the benefit of possessing the collections of books both of Professor Baird and Dr. Goode.

THE AGRICULTURAL EXPERIMENT STATIONS.*

THIS is the fourth annual report on the work and expenditures of the agricultural experiment stations in the United States, made by the Director of the Office of Experiment Stations, under instructions from the Secretary of Agriculture. As heretofore, the report is based on three sources of information, viz, the annual financial statements of the stations, rendered on the schedules prescribed by the Secretary of Agriculture, in accordance with the Act of Congress; the printed reports and bulletins of the stations, and the reports of personal examinations of the work and expenditures of the stations made during the past year by the Director, Assistant Director and one other expert officer of the Office of Experiment Stations. The stations in all the States and Territories were visited since the previous report was transmitted to Congress.

During the past year the stations have, as a rule, steadily pursued their investigations. There have been a smaller number of changes in the workers; the general management has been less subject to radical and unwise changes; much useful work has been accomplished, and the facilities for investigations have been increased.

RELATIONS OF COLLEGES AND STATIONS.

There has been much activity during the past year in the developing and strengthening of courses of instruction in agricul-

* From Report to Congress on Work and Expenditures of Agricultural Experiment Stations for 1898.

ture in the land-grant colleges with which the stations are connected. This has been to the advantage of the stations in a number of ways. The buildings and equipment of the colleges have been materially increased, and this has given the stations better facilities for their work. The instruction in agriculture has been specialized, which has necessitated the employment of a larger number of well-trained officers, many of whom have devoted a portion of their time to station work. The governing boards and general officers of the colleges are coming to see more clearly the real significance and importance of experiment station work. They have, therefore, been more willing to make proper arrangements for the efficient conduct of this work and to pursue a more liberal policy toward the stations. In a number of instances there has been a more definite separation of the operations on the farms and in the barns, creameries, laboratories, etc., so that a definite place has been made for original investigations in agriculture, and these have been clearly differentiated from the work and facilities connected with instruction. It is coming also to be more clearly seen that care must be taken lest the routine duties connected with instruction shall so exhaust the energies of the officer employed in both college and station that he will not be able to devote his best energies to the more difficult task of originating and conducting successful investigations in agricultural science. The outlook is, therefore, more hopeful for the building up, in connection with these institutions, of strong departments of original investigation on behalf of agriculture, which shall not only accomplish great good by the practical results of the investigations disseminated among the farmers, but shall also materially aid in the proper development of courses of instruction in agriculture in the land-grant institutions.

THE ORIGINAL INVESTIGATIONS OF THE STATIONS.

The year past has shown considerable progress in the importance and thoroughness of the original investigations pursued at our stations. The number of officers competent to undertake such investigations has been increased. There has been greater specialization of the work assigned to these officers. There have also been encouraging indications that cooperation between the officers engaged in different lines of investigation is being more efficiently secured. More attention is being given to the consideration of problems which affect in a general way important agricultural interests in the several States or are of fundamental importance in different branches of agriculture wherever pursued. It is becoming more clear that it is much better for an individual station to undertake thorough original investigations in a few lines and hold steadily to these until definite results are secured than to scatter the work among a variety of small operations. If a station can make itself preeminent for original work in even one or two lines it gains strength in its own State and elsewhere which it could get in no other way; and now, that general information regarding the work of all the stations is more widely disseminated, there is less reason why any one station should attempt very many lines of work. The success of those stations which have devoted themselves most largely to original investigations has, without doubt, been a powerful factor in stimulating the general adoption of such a policy. The wisdom of the framers of the Hatch Act in limiting the work of the stations organized under that act to original and scientific investigations which shall either attack agricultural problems in a new way or have reference to the application of ascertained facts or principles to particular or local phases of these problems is more and more

apparent. Every dollar of the fund thus given from the National Treasury is needed for thorough original investigations on behalf of the vast and varied interests of agriculture in this country and the dissemination of the results of such investigations. The more strictly this fund is applied to these purposes the more rapid development will our agriculture have along the lines of permanent success.

DEMONSTRATION EXPERIMENTS.

As the work of the stations develops it is seen that more adequate provision should be made for the application of the results obtained by the stations in actual practice in different localities, in order that the best methods of local application of these results may be worked out, and that the farmers may be taught how to make the best use of the work of the stations. It is in this direction that there is the greatest need for a generous policy on the part of the States toward the stations. By supplementing the Hatch fund for work of this kind the States in a number of cases have greatly hastened the direct application of the results of original investigations to actual farm practice, and have done much toward arousing the farmers to a keener sense of the practical value of station work. With the aid of funds furnished by the States and by this Department thousands of the more simple experiments in the growing of different crops, such as sugar beets, and the use of fertilizers, have been made by farmers in different parts of the country. It is much to be hoped that the States will more fully take up this work, and that it will be more thoroughly organized, as is being done, for example, in the State of New York, where special appropriations have been made for experiments of this character under the direction of the stations. A great deal of the work of the testing of varieties of agricultural and horticultural plants, to be of any

practical value, needs to be carried on in a number of different localities in each State, and this can probably be most economically and efficiently done with the cooperation of intelligent practical farmers and horticulturists. While cooperative experiments may often be of value in connection with original investigations, they will most often be of use in determining the extent to which the results of such investigations may be applied in actual practice.

DISSEMINATION OF INFORMATION.

The Hatch Act expressly provides that a portion of the funds granted the stations by the United States shall be expended for printing and distributing reports and bulletins, but limits the scope of the information to be thus published to the 'results' of their investigations. The act further grants the stations the franking privilege for the distribution of their publications. Circumstances have compelled the stations to go far beyond the limit set by the Act of Congress as regards the character of the information which they have disseminated. A number of causes have contributed to make a very heavy demand upon the stations for information regarding every detail of farm theory and practice. The successful issue of many of the investigations of the stations has been a very important factor in creating this demand. There has also been the necessity of giving the farmers preliminary information along the line of many investigations, in order that they might clearly understand the practical application of the new results which the stations had obtained. But beyond this there has been during the last decade a remarkable awakening of our farmers to the desirability of having more definite information regarding all matters connected with their business. The result has been that the stations and this Department have been led to publish a vast amount of information, both old and

new, which has been freely distributed to farmers in every county of the Union. Nothing like it has ever been seen before. No country has ever before attempted so systematic and thorough a distribution of information to its agricultural population, and no masses of farmers have ever so eagerly sought for information as have our own within the past few years; and not only has the free information furnished by the stations, and the Department been eagerly sought for, but this period has also been remarkable for the amount of accurate information distributed to the farmers through the agricultural press and other newspapers and the number of good books on farming which have been published. Besides this, the agricultural societies, granges, farmers' institutes, and other associations have been more active than ever before in discussing the problems of agriculture and in securing the services of experts and successful practical men to lay before them the fruits of science and experience for the more successful conduct of the art of agriculture. Such an intellectual awakening must have most important results, and there is every indication that it will go on increasing in volume and force until it has thoroughly permeated the entire agricultural population of the country.

To secure the best results such a movement needs the wisest leadership to guide its aspirations in the best directions. Fortunately the facilities for agricultural education of a high order have been greatly increased within a few years, and there is to day a much larger number of well-trained men who are competent to give the farmers the information which they demand than was the case ten years ago. What is especially needed now is the more thorough organization of the agencies for the diffusion of information among the farmers. Thus far the officers of our agricultural colleges and experiment stations have had to

bear the heaviest portion of this burden, and it is much to be wondered at that they have so well discharged the great variety of duties imposed upon them; but the time has come when there must be a specialization of work in this as in other directions if we are to have the most efficient agencies for the securing as well as for the disseminating of agricultural information.

Everybody now admits that much may be done to advance agriculture by scientific investigations, but the absorbing character of this work, if it is to be well done, is not as yet thoroughly appreciated. The discovery of new truth is the chief function of our experiment stations, but the amount of new truth which they will discover will be very largely determined by the extent to which the investigators are left to pursue their investigations without interruption. The same is true regarding the teacher in our agricultural colleges. He must have time to keep pace with the increasing volume of new information which is being published, and be able to give his best energies to the planning of courses of study, and come before his pupils with an active mind, in order that he may not only impart knowledge to them, but may inspire them with something of his own enthusiasm regarding the subjects which he teaches. The writer of popular bulletins and books for farmers must not only have ample knowledge, but he must have had time to acquire the most complete sympathy with his readers and a style of composition which is confessedly the most difficult to attain. The farmers' institute worker should not only have wide familiarity with the science and practice of agriculture, but he should also have a ready wit and the fine art of putting things in a clear light and changing his point of view according to his audience, which can only come through natural aptitude combined with much experience in public speaking. Many of our

best investigators and teachers have a wonderful versatility, so that they succeed pretty well in a number of different lines of work, but after all there is some one direction in which they excel, and one or the other feature of their work is almost sure to suffer if they attempt a great variety of performances. We must in the future leave the investigators more fully to their investigating, the teachers to their teaching, the writers of agricultural publications to their writing, and the farmers' institute workers to their speaking.

Already the movement in this direction has begun. In our colleges changes are being made by which the experiment station offices are given more time for their investigations, and additional teachers are being employed. One of our stations has recently employed an officer whose chief business it is to edit the station publications and prepare popular bulletins for the farmers. At another institution the superintendent of farmers' institutes is a separate officer, and in a few States a corps of institute workers, exclusive of the college and station officers, has been organized. This movement should be encouraged, and the governing boards should see to it that the officers of stations are protected against unreasonable demands on their time, which would take them away from the planning and conducting of thorough original investigations.

We do not urge this because we wish to limit the dissemination of compiled information to our farmers. We fully recognize the importance of this, and we would have the States and the National Government make ample provision for compiling and publishing all the information which our farmers ought to have. But we would insist more strongly than ever that original investigations by our experiment stations should be made more thorough and increased in number, in order that the stream

of new information may increase in purity and volume with every year.

LIBERALITY OF THE STATES.

One of the most encouraging things connected with the progress of our experiment stations has been the disposition of the State Legislatures to deal more liberally with them as the importance of their work has become more apparent. This liberality has manifested itself in a number of ways. There have been large grants of money directly for experiment-station purposes. In the erection of buildings for the colleges provision has often been made for increasing the facilities for experiment-station work. The printing of station publications is regularly done in a number of States at the public expense. The laws relating to inspection of agricultural commodities have been so framed that a considerable revenue has accrued to the stations for purposes of investigation. The increased means thus acquired have enabled the stations in a number of States to push their work far beyond what could have been accomplished with the Hatch fund alone. In comparing the work of different stations this factor should always be taken into account, and communities in which a more narrow policy has been pursued must not expect that their stations will be able to do as much for their agriculture as is accomplished by stations receiving more liberal treatment.

We believe that under our American system nothing can be more promotive of the highest interests of the stations than that the States should take a just pride in strengthening and developing their operations, and thus prove to the world that scientific institutions based upon the support of the people can be made as strong and efficient as those which are directly maintained under the centralized authority of the General Government.

POLITICAL INTERFERENCE AND THE INJURY
TO SOME STATIONS THEREBY.

While as a rule our stations have been free from the baneful influence of the introduction of political considerations into their management, there are still some States and Territories in which politics have been a disturbing element in the affairs of the stations during the past year. This has resulted in unreasonable changes in the membership of the governing boards, the removal of efficient officers without cause or on inconsequential pretexts, and, in a few cases, in the appointment of notoriously incompetent men as station officers. This Department has consistently held that where such an unsettled state of affairs exists the real objects of the Hatch Act can not be attained, since these involve, first of all, a corps of competent specialists working under a well-defined policy, outlined to cover a series of years of interrupted investigation, and having an assurance that their work will be judged on its merits. It was not hesitated to protest against the action of governing boards wherever there was a plain case of violation of the proper principles of station management. The communities which permit such things, of course, reap their reward in the weakness or inefficiency of the operations of the stations. The remedy lies very largely with the people, and every effort should be made to form intelligent public sentiment on this subject.

AGRICULTURAL INVESTIGATIONS IN ALASKA.

For the past two years Congress has included in the appropriation for agricultural experiment stations an item for investigations regarding the agricultural capabilities of Alaska, with the special object of determining the desirability and feasibility of establishing agricultural experiment stations in that Territory. With the first year's appropriation a preliminary agricultural and botanical survey of Alaska was made, a

report on which was transmitted to Congress. The results of this reconnoissance were so encouraging that the appropriation for this work was doubled, and during the present year not only has the survey been continued, but reservations of land have been made at Sitka, Kadiak and Kenai in Cook Inlet, and some successful experiments in growing and maturing barley, oats, flax, potatoes and other vegetables have been made, and excellent clover and grasses have been grown under cultivation. The detailed report of this work will soon be transmitted to Congress, and it is hoped that hereafter Alaska will receive at least the same financial support for experiments in agriculture as is given to the other portions of the United States by the National Government.

EXPERIMENT STATION IN HAWAII.

The Hawaiian Islands having been annexed to the United States, the question of the development of their agriculture through experimental inquiries, conducted on the same plan as in other parts of the United States, has become an important one. It seems proper, therefore, in this connection to call attention to the fact that an experiment station has been in successful operation at Honolulu since 1895. This station is under the direction of the Hawaiian Sugar Planters' Association, which supplies the funds for its maintenance. The Director and Chief Chemist is Dr. Walter Maxwell, formerly an assistant in the Division of Chemistry in this Department, and later one of the chemists of the Louisiana Experiment Stations. The other members of the staff are two chemists and a field assistant. This station has studied especially the problems relating to the culture of sugar cane and the manufacture of cane sugar, but there have also been experiments with fertilizers, and a comprehensive investigation of the soils of the Islands. The results

of the station's work have been published in the *Hawaiian Planters' Monthly*, and in bulletin form. The station has been ably directed, and its work has been systematically and successfully pursued.

THE OFFICE OF EXPERIMENT STATIONS.

Besides the work done in the supervision of expenditures of the stations and in conferences and correspondence with station officers, this office has continued to collect and disseminate information regarding the progress of agricultural investigations throughout the world. Not only has this feature of its work been made more thorough, as regards the review of the literature of agricultural science for the benefit of our station workers, but the preparation of popular *résumés* of station work has been more systematically pursued. A series of such publications, denominated Experiment-Station Work, has been begun in connection with the Farmers' Bulletins issued by the Department.

During the year the office issued about 43 documents, aggregating 2,920 pages. These include 13 numbers of the Experiment Station Record, with detailed index, 12 bulletins, 7 Farmers' Bulletins (including 4 numbers of the subseries entitled 'Experiment Station Work'), 1 circular, 4 articles for the Year Book of the Department, the annual report of the Director, a report to Congress on the work and expenditures of the experiment stations, and 4 special articles published as separates.

The ninth volume of the Experiment Station Record comprises 1,214 pages, and contains abstracts of 317 bulletins and 56 annual reports of 53 experiment stations in the United States, 201 publications of the Department of Agriculture, and 842 reports of foreign investigations. The total number of pages in these publications is 56,569. The total number of articles abstracted is 1,810, classified as follows: Chemistry,

121; botany, 86; fermentation and bacteriology, 28; zoology, 31; meteorology, 57; water and soils, 72; fertilizers, 85; field crops, 153; horticulture, 138; forestry, 16; seeds and weeds, 41; diseases of plants, 107; entomology, 252; foods and animal production, 186; dairy farming and dairying, 151; veterinary science, 134; technology, 11; agricultural engineering, 38; statistics, 103. Classified lists of articles, in some cases with brief abstracts, are also given in each number. The aggregate number of titles thus reported is 2,471.

STATISTICS OF THE STATIONS.

Agricultural experiment stations are now in operation, under the Act of Congress of March 2, 1887, in all the States and Territories. As stated above, agricultural experiments have been begun in Alaska with the aid of national funds, and an experiment station is in operation in Hawaii under private auspices. In each of the States of Alabama, Connecticut, New Jersey and New York a separate station is maintained, wholly or in part, by State funds, and in Louisiana a station for sugar experiments is maintained, partly by funds contributed by sugar planters. Excluding the branch stations established in several States, the total number of stations in the United States is 54. Of these, 52 receive the appropriation provided for in the Act of Congress above mentioned. The total income of the stations during 1898 was \$1,210,921.17, of which \$720,000.00 was received from the National Government; the remainder, \$490,921.17, coming from the following sources: State governments, \$341,897.94; individuals and communities, \$177.20; fees for analyses of fertilizers, \$93,677.00; sales of farm products, \$65,358.25; miscellaneous, \$20,312.48. In addition to this the Office of Experiment Stations had an appropriation of \$35,000 for the past fiscal year, including \$5,000 for

the Alaskan investigation. The value of additions to equipment of the stations in 1898 is estimated as follows: Buildings, \$109,851.65; libraries, \$11,700.73; apparatus, \$19,195.43; farm implements, \$10,800.27; live stock, \$13,151.33; miscellaneous, \$11,972.97; total, \$176,469.41.

The stations employ 669 persons in the work of administration and inquiry. The number of officers engaged in the different lines of work is as follows: Directors, 75; chemists, 148; agriculturists, 71; experts in animal husbandry, 10; horticulturists, 77; farm foremen, 29; dairymen, 21; botanists, 50; entomologists, 46; veterinarians, 26; meteorologists, 20; biologists, 11; physicists, 11; geologists, 6; mycologists and bacteriologists, 19; irrigation engineers, 7; in charge of substations, 15; secretaries and treasurers, 23; librarians, 10, and clerks, 46. There are also 21 persons classified under the head of "miscellaneous," including superintendents of gardens, grounds and buildings, apiarists, herdsman, etc. Three hundred and five station officers do more or less teaching in the colleges with which the stations are connected.

During 1898 the stations published 406 annual reports and bulletins. Besides regular reports and bulletins, a number of the stations issued press bulletins, which were widely reproduced in the agricultural and county papers. The mailing lists of the stations now aggregate half a million names. Correspondence with farmers steadily increases, and calls upon station officers for public addresses at institutes and other meetings of farmers are more numerous each year. The station officers continue to contribute many articles on special topics to agricultural and scientific journals. A number of books on agricultural subjects, written by station officers, have been published during the past year.

A. C. TRUE.

U. S. DEPARTMENT OF AGRICULTURE.

PHYSIOLOGICAL OSMOSIS.

IN going over this subject I have discovered a very simple method, which I would offer as an improvement on that of van't Hoff, referred to, and its results given by Starling in Schaefer's 'Physiology.'

All methods as to osmotic pressure are an application of the discovery that it is the largeness or smallness of the chemical molecules of solutes (matters in solution) that determines whether they shall be estopped by or shall pass through membranes. Citing common-places of chemistry, we know that a gram-molecule of hydrogen gas, with a numerical value of 2, has the same volume as a gram-molecule of oxygen, weighing 32 per molecule, and as a gram-molecule of cane sugar dissolved in water, having a molecular weight of 342 and when in solution acting like a gas. The common volume of a gram-molecule of each of these substances, at 0°C. and ordinary barometric pressure, is 22.32 liters; if the gases be compressed to the volume of 1 liter they will exercise a pressure of 22.32 atmospheres per gram-molecule. This is the result with all solutions in water when taken according to their molecular pressure. But it will not apply to electrolytes, as these are broken up by the water; thus for sodium chlorid the value is 1.6 times this amount.

Taking as an example a 1 per cent. solution of cane-sugar in water, a gram-molecule, that is 342 grams, of the sugar are dissolved in 34,200 grams of water, or $\frac{1}{100}$ of a gram-molecule in a liter of water. This will, therefore, exert $\frac{1}{100}$ of 22.32 atmospheres of pressure; or taking 10.33 meters of water pressure for an atmosphere, we find from the osmotic pressure of the solution at 0°C. $p = \frac{1}{100} \times 22.32 \times 10.33 = 6.748$ meters of water-pressure.

At the ordinary temperature of the body, 37°C., this will be increased by $\frac{3}{17}$ of

itself, giving 7.662 water-meters, or about 25 feet of water-pressure.

For any other solute than sugar we have only to substitute its molecular weight for the denomination 342 in the above work. Substituting 2 for it, for hydrogen, the result is 1153 water-meters, a forcible token of its lively diffusibility.

The Freezing-Point.—Though this has no connection with physiology, the lowering of the freezing-point in solution is cited by Starling as a step towards finding osmotic-pressure, which we have seen to be determinable in a less troublesome way. We give the converse case; having found the pressure, to ascertain by its aid the freezing point of a 1 p. c. solution of cane-sugar.

The law of thermodynamics gives this proportion :

$$\frac{\text{Work done}}{\text{Heat during it}} = \frac{\text{Lowering } (\Delta) \text{ of Total Heat}}{\text{Total Heat.}}$$

In this case the work done is 6.748 water-meters-pressure (as was found above). The heat doing it is the latent part of water, 79.9 calories per gram, which is reduced to water-meters-pressure by multiplying by 427.

The total heat is the absolute temperature at 0°C.; this is 273. Thus the proportion becomes

$$\frac{6.748}{427 (79.9)} = \frac{\Delta}{273},$$

giving $\Delta = 0^{\circ}.054$ C. This result is substantially identical with that cited by Starling from van't Hoff, and signifies that the particular solution of sugar in water lowers the freezing-point more than one-twentieth of a degree. If the solution had represented a gram-molecule of sugar in a liter of water the depression of the freezing-point would be nearly 2°C., a constant well-known to physicists.

Writers on physiology usually state that processes of absorption within the body are more rapid than can be fully explained by experiments on diffusion. A partial explanation of this peculiarity will, I think, be found in the fact that experiments are made on dead and comparatively rigid membranes, and the living membranes of the body are almost fluid in their softness. Whether osmosis be by a transitory combination or by passing through temporary pores, it involves in the living body a minimum of friction. We know how much more rapidly blood can pass through flexible, living vessels than through rigid tubes.

(I am indebted to my colleague Professor E. H. Loomis for advice.)

GEORGE MACLOSIE.

PRINCETON UNIVERSITY.

January 5, 1899.

PROFESSIONAL SCHOOLS VS. BUSINESS.

AN exceedingly interesting and instructive experiment has been in progress during the last few years at Sibley College, Cornell University, the outcome of which will perhaps have peculiar interest for all who are concerned with education and professional training, the data of which experiment are exhibited in the accompanying diagram, showing the growth in numbers of that college from its date of reorganization as a professional school, in 1885, to the present time. The diagram is taken from the paper read before the Association of Promotion of Engineering Education, at the Boston meeting of 1898, by the writer.

Up to the year 1885 Sibley College was without expert direction, a definite policy, a settled curriculum or a systematically organized faculty. It had been established as a 'school of the mechanic arts' for many years, but had not graduated a hundred students in its whole career. In 1885 the Trustees of the University found themselves in a position to undertake the work

of reorganization and reconstruction on a higher plane and in a more modern way. Mr. H. Sibley had enlarged and improved the College buildings and greatly added to the outfit of laboratory apparatus and workshops, and it was considered practicable to undertake the inauguration of schools of undergraduate and post-graduate work in the various branches of mechanical engineering and the mechanic arts. Space was available and the apparatus was sufficient to meet the needs, as was thought, of as many as 200 students in its various departments. The institution was placed in the hands of a Faculty composed entirely of professional experts; the course was reconstructed and made mainly technical; the entrance requirements were made to accord, as closely as was thought practicable, with those of the most advanced of existing schools of a similar class, and the equipment was made modern in character and exceptionally extensive in each of its professional branches.

Later, special courses were established, undergraduate and advanced, in electrical engineering, in marine engineering, in railway machine construction, etc., and the College was brought into the form now familiar to our professional educators and technical men.

The immediate result of this reconstruction of the institution was to bring up the attendance from an average, for the earlier years, of about a dozen, with an average of five in the graduating classes, to about a hundred; while the graduating classes in the course of the next four years ran up to 30, in ten years to 100, and while the student-list increased to 400 in five years and to 634 in less than ten. In two years the College had reached its originally estimated limit, and the Director was compelled to notify the Trustees that some means must be found to prevent overcrowding. It was attempted to restrict admissions to the

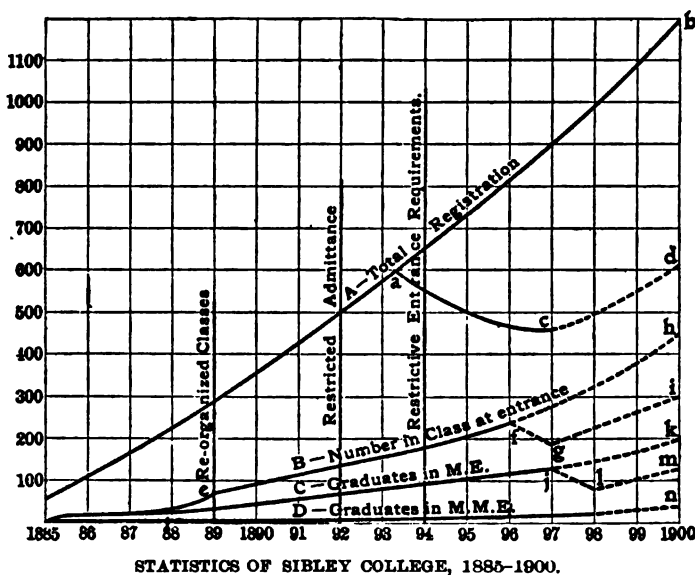
freshman class; but this proved ineffective, as students would then enter other departments of the University, and, later, transfer to the upper classes of Sibley College. Meantime the numbers increased; the faculty was enlarged, new buildings were added and equipment greatly increased, without relief from the continual overcrowding and pressure in all departments and in every phase of work.

Finally it was concluded to adopt a radical and certain method of checking an influx of students which threatened to demoralize the institution by flooding all departments and overworking the whole staff, while, hardly less serious, making heavy inroads upon the always hard-pressed income of the University, which was already overloaded by the enormous demands of the State of New York for State scholarships—now 600 in number—for which no compensation was made to the University. The immediate outcome was the cutting-down of the entering classes 40 per cent., by demanding of them an additional year in mathematics; permitting the freshmen to take up analytical geometry and the calculus, and the sophomores to give their time for the year, in that branch, to applied mechanics, the backbone of every technical course. This was done in 1893, and classes which would have entered about 175 strong were pruned down, by this exclusion of the weakest applicants, to something above 100. The 'cream was skimmed' and a magnificent body of students thus secured; but the result, on the other hand, was then and later the compelling of hundreds of young men to go directly into business, who, otherwise, would have secured a systematic and scientific preparation for their life's work. The facts of this very interesting case are shown in the accompanying diagram, originally from the report of the Director of Sibley College to the Board of Trustees of Cornell University, June,

1898. The experiment, in so definite and conclusive a form, is so unexampled and the results so exceedingly instructive and suggestive to faculties, or others proposing to deal in a radical manner with so delicate a subject, that it has been thought that a wide circulation of these facts would prove acceptable and useful in many ways.

In illustration of the sensitiveness of the average technical college to changes in entrance requirements and consequent changes in its relations to the preparatory schools as now customarily conducted, ignoring demands of any other than aca-

entrance and of the course itself, meantime. Referring to the diagram: Following the upper line, *A*, we observe that the total registration began rising instantly upon the establishment of an engineering course, from about 100, in 1886, to 200, nearly, in 1887, 300 in '89, 400 in '90, 500 in '92, and to 638 in the year terminating June, 1894. At this point the non-professional entrance requirements were raised by demanding an additional year of higher mathematics, thus permitting the freshmen to take up analytical geometry and the calculus, and the sophomore class to study and complete



demic colleges and universities, it will be instructive to study the accompanying diagrammatic representation of the working of such a change compelled by the increase in numbers of students beyond what was at the time thought a limit for good work and of suitable equipment and accommodations.

The accompanying diagram presents the statistics of growth of Sibley College from 1885, the date of its organization upon its present basis, to 1897-8, and the presumptive changes to A. D. 1900, assuming no further modification of the conditions of

applied mechanics—a change which proved of enormous advantage in improvement of the course of study. But the registration necessarily at once dropped off to lower figures, until, in the year 1896-7, the registration of undergraduates was less than 500.

On the other hand, the numbers of the graduating classes continued to rise until this change had its full effect, and numbered 125 in June, '97, but will not exceed, probably, 95 in '99; after which date it may be expected to again resume its upward march. Curves *B* and *C* show the num-

bers of these classes at graduation and at their entrance into the College.

The line *a b* indicates what might have been expected had no such radical and unprecedented increase of the demands at entrance been made. The College would, at its then rate of growth, have attained a census of 1,000 students in 1898 or 1900, possibly 1,200 in the latter year. Numbers were then restricted by thus cutting the expectant entrance-class in half and its numbers fell as shown, and the dotted line, *c d*, indicates where the figures will probably reach, at those dates, as now thus reduced. Similarly, the lines *f h* and *g i* show what numbers were promised, between the specified dates, under the one, and what under the later, arrangement. The lines *j k* and *l m* show what should have been and what actually will probably be the magnitude of the graduating classes, in 1898 to 1900, inclusive. The line *D* indicates the number of students taking the Master's degree. The peculiar 'hump' at the date '89, on *B*, indicates the effect of the unsuccessful attempt to restrict numbers at that date by limiting the number accepted.

Just what is to be considered the real balance between advantage and disadvantage due the noted elevation of the entrance requirements, in '94, is perhaps difficult to decide. It has given a vastly better course; but the difference between the lines *a b* and *c d* shows that the College has lost the opportunity to benefit many hundreds of students who have, as it is, been compelled, in most cases, probably, to go into business without professional training and who are thus placed almost hopelessly in the rear of their more fortunate fellows in their struggle for success through life.*

R. H. THURSTON.

SIBLEY COLLEGE, CORNELL
UNIVERSITY, January 2, 1898.

* Proceedings Society for Promotion of Engineering Education, 1898.

MECHANICAL ILLUSTRATION OF KIRCHHOFF'S PRINCIPLE.

IN teaching the reversal of the metallic lines in the Fraunhofer spectrum it is often difficult for the student to get a concrete idea of the principle that a molecule or atom will absorb especially radiant energy whose period is identical with the inherent period of the molecule itself.

A customary method of illustrating this point is with two tuning forks upon resonance boxes, but this requires very careful manipulation and is not altogether satisfactory. The following method has proved quite satisfactory:

The suggestion of Lord Kelvin for a mechanical illustration of a molecule having inherent periods of vibration is used, replacing his spherical shells by rings. Such a molecule with one rate is shown in Fig. I.

The ring *A* is about 20 cm. in diameter and made of brass rod about 1 cm. in diameter; the ball *B* is preferably somewhere near the same mass as the ring *A*. The three spiral springs *S* are wound about 2 cm. diameter of about No. 22 hard brass wire.

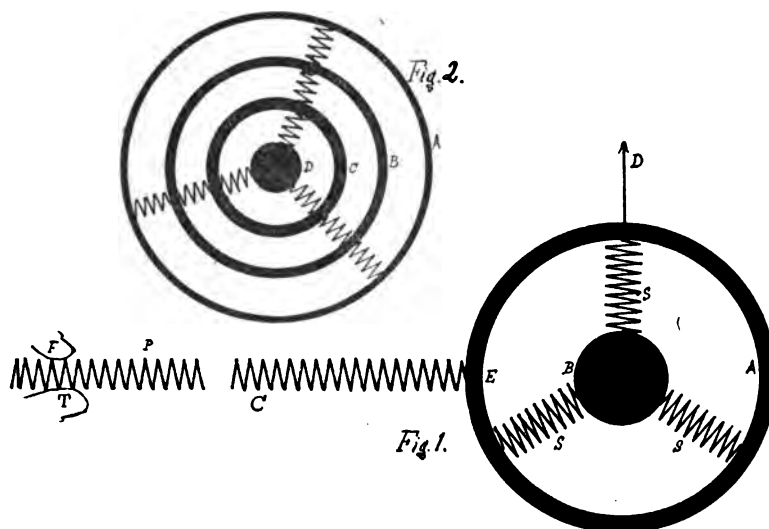
Such a molecule has a rate of vibration of about 4 or 5 per second when suspended on a long string as at *D*. A close spiral spring *C*, similar to *S*, but about 50 cm. long, is attached to the ring at *E*, the other end being held between the thumb and finger at *TF*.

While holding this spring slightly tense it can be set into longitudinal stationary waves by compressing the part at *P* toward *TF* and then letting go. The period of these vibrations depends upon the length *TF* to *E*. Commencing with this length about 15 to 20 cm., it will be observed that the stationary waves in *C* do not effect the molecule. Taking *C* longer and longer a point is reached where the waves in *C* are taken up and a decided vibration is set up between *A* and *B*. That is, the molecule absorbs the energy from *C* when its period

is the same as its own inherent period. If the length of *C* be now slightly changed, the phenomenon of beats is readily apparent.

An electric arc will throw a sharp shadow of this apparatus upon a screen and make the experiment visible to a large audience. The spring *C* may be replaced by an electri-

casts or impressions. The materials commonly used for this purpose are beeswax (either pure or mixed with some stiffening substance, such as ozocerite or paraffine), dentists' modeling composition (which must first be softened in water heated nearly to the boiling point), glue, gelatine, melted



cally excited tuning fork or other mechanical appliance.

The armature of a small electro-magnet may be attached to the ring at *E* and the current interrupted by some mechanical circuit breaker whose rate can be varied.

A molecule like Fig. 2 would have several inherent rates depending upon the relative masses of *A*, *B*, *C*, *D* and upon their connecting springs. Ingenuity will suggest many variations or improvements upon these suggestions.

WILLIAM HALLOCK.

PHYSICAL LABORATORY,
COLUMBIA UNIVERSITY.

PLASTILINE, A NEW MODELING COMPOUND.

PALEONTOLOGISTS have constantly to deal with organic remains preserved in the rock in the form of natural casts, molds and impressions, for the proper study of which it is indispensable to take reverse

casts, and, of course, the common plaster of paris. One writer* has suggested the use of tinfoil for taking repoussé impressions, the foil being afterwards coated with varnish to insure retention of its shape.

Each of the above-named substances has its own special advantages and applicability in certain cases. But a comparatively new plastic material which is especially well adapted for modeling purposes, and hence is of interest to the taxidermist, cartographer and others, is that known as *plastiline*. This is the invention of Professor Luigi Giudice, of Genoa, Italy, by whom it has recently been perfected, and is,

* Goodchild, H. G., How to take Impressions of Fossils (Geol. Mag. [3], Vol. IX., p. 206), 1892. See also, for various hints on modeling: Osborn, H. F., Models of extinct Vertebrates (SCIENCE, Vol. VII., p. 841), 1897. Davis, W. M., and Curtis, G. C., The Harvard Geographical Models (Proc. Boston Soc. Nat. Hist., Vol. XXVIII., p. 85), 1897.

we believe, exclusively prepared. It was brought to the writer's attention not long since through his friend Miss Hyatt, the well-known sculptor of Cambridge, who states that it has come into general use among artists during the past few years. It does not appear, however, to have become known, or at least extensively employed in natural history laboratories, as it certainly deserves to be.

The following properties are claimed for plastiline in a circular obtained by the principal dealers in this country, Messrs. L. P. Pastorini & Co., of 1140 Third Avenue, New York :

"It is lighter than clay, does not dry nor contract, and remains firmly attached where it is placed, whatever be the quantity employed. It will not mildew nor produce any other fungus growth; will preserve indefinitely the shape given it, its color, and its adhesive and plastic properties. Heat or cold, and dryness or moisture of the atmosphere, have no effect upon it, whether exposed or hermetically sealed. Another great advantage is its harmlessness to health.

"Plastiline is used in exactly the same way as clay. A layer or two of painters' glue applied upon the wooden framework of the model or base will prevent any absorption of plastiline and greatly facilitate the latter's adhesion. To take the impression of an object and to prevent the composition from adhering to the original, powder the plastiline with pulverized talcum (glove powder). Plastiline does not adhere to the plaster when a cast is made. To insure the easy removal of the latter, simply bathe with water the outside of the plaster cast, when it will detach readily.* To give a finer finish to certain parts of the model, the application of a brush with alcohol or spirits of turpentine is recommended."

Plastiline is supplied in three grades of consistency; No. 1 being the softest, or about the same as glazier's putty; No. 2 being medium soft, and No. 3 medium hard. For taking impressions of fossils we have found No. 2 very satisfactory, but to render it more plastic one has only to knead it with a little vaseline or sweet oil. The best

* For taking plaster casts directly from natural objects no better lubricant can be employed than a mixture of vaseline and refined kerosene oil.

modeling tools are those used by sculptors, which consist of fine iron or brass wire wound evenly about a stiff wire loop and fastened to a short handle. One should always make his own tools, however, taking care to get the coils fine and even. Box-wood spatulas, sand-papered down to a thin edge, or even steel ones, such as plasterers use, are convenient for shaping in the rough.

The chief advantages of this compound consist in its non-liability to crack or dry up—hence it retains the most delicate impressions indefinitely; in its durability, as the same material can be used over again; in the ease with which plaster casts can be taken from it; and finally in its general convenience, being always ready for use and not requiring any care. For these reasons we have thought it worth while to bring it more prominently before the notice of naturalists.

C. R. EASTMAN.

SCIENTIFIC BOOKS.

The Structure and Classification of Birds. By FRANK E. BEDDARD, M.A., F.R.S., Prosecutor and Vice-Secretary of the Zoological Society of London. London, New York and Bombay, Longmans, Green and Co. 1898. Pp. xx + 548, with 252 text figures. Price, \$6.00.

Mr. Beddard is to be congratulated upon having brought to a successful issue a task contemplated, and even commenced, by his predecessors, Garrod and Forbes, and as these by their labors have done much to further the work, and as their note-books have been freely drawn upon, they too may be credited with a share in the finished product. While we may admit that a hand-book on avian anatomy is scarcely so much needed now as it was when conceived by Garrod, the present volume is none the less welcome. The monumental treatise of Fuerbringer and the detailed work of Gadow are not at everyone's disposal, and there are still ornithologists who, to their sorrow, have failed to acquire that knowledge of German which is now almost indispensable to the orni-

thologist. Hence this book, replete with anatomical facts, is one that no working ornithologist can afford to do without. Not only does it contain a vast amount of original work, but a host of references to that of others, and if, as stated in the preface, one bird is occasionally described under two names this is of small consequence. It is a poor bird that does not rejoice in at least two names, and there is no danger now-a-days that questions of nomenclature will suffer from neglect.

The first 158 pages are devoted to the structure of birds, their more common anatomical features being described under such heads as pterylosis, alimentary canal, respiratory system, etc. Then follow 376 pages on the classification of birds where the structural characters of each group are given in detail and the affinities of each division discussed at some length. As Beddard and his immediate predecessors in the prosectorial chair have been more deeply interested in the soft anatomy of birds than in their osteology, it is not surprising to find the book particularly strong in those portions relating to myology and to the detailed structure of the syrinx and alimentary canal. The amount of original research displayed in these directions can but excite the admiration of anyone who has tried his hand at the dissection of small birds and found how trying it is alike to temper and eyesight.

This being the case the occasional slighting of osteological characters—for instance, little or nothing is said concerning the hypotarsus—may be readily forgiven, as well as the rare errors, mostly due to generalizations based on insufficient data. For example, almost on the first page we find the time-worn misstatement that in the Swifts all four toes are directed forward when this applies mainly, or wholly, to the true Swifts, *Micropodinae*, since *Hemiprocne*, and probably *Macropteryx*, cannot, and the common species of *Chaetura* do not, turn the first toe forward. Dr. Stejneger and Dr. Coues have both stated the case correctly, and it is a pity to have this error perpetuated. That the patella of the Comprants is perforated by the tendon of the ambiens is but partially true; it is thus perforated in *carbo*, *dilophus* and *vigua*; it is not in *urile*, *penicillatus*, *punctatus* and *melanoleucus*,

while the orifice is minute in *magellanicus* and *albiventer*.

A slip of another kind is made in describing the hyoid, where the text neither agrees with the facts nor with the figure on the opposite page; this last, however, is hardly to be wondered at when scarcely any two writers are agreed as to the nomenclature of the parts of a bird's hyoid, and the majority seem in some particular to be incorrect. These little errors are pointed out merely to emphasize the danger of generalizations from observations on a few members of an apparently homogeneous group, and to note that the field of avian anatomy is so large that even the most diligent laborer therein may overlook some of the distant corners.

Passing to the portion on classification it may be said in the main that the groups are those adopted by Fuerbringer and Stejneger. Beddard's divisions (orders?), corresponding, in a general way, to the super-families of Stejneger as given in the Standard Natural History. There is naturally some shifting about of debatable forms, for it is not probable that any two writers would agree on all points of classification, this largely because birds, as a class, are so homogeneous, while their minor modifications are so infinite, that their arrangement is a difficult matter. To add to the difficulty, the tendency is for convenience to pitch the divisions on too high a key, so that they are not comparable to those of other vertebrates.

The two principal divisions are, like those of Fuerbringer, *Saururæ* and *Ornithuræ*, the latter being sub-divided into *Anomalogonatae* and *Homalogonatae*, although, by a strange oversight, the latter group is only incidentally defined (p. 95), and is not even mentioned in the contents, and only by the process of elimination can we ascertain what birds belong to it.

A similar lapse occurs in treating of the Galli, where, on page 302, we are told the Alectoropodes may readily be divided into three groups and only two groups are given, while, to complicate matters still further, four families are spoken of a little later on.

Perhaps this may be considered as atoned for by the casting overboard of the divisions *Ratilæ* and *Carinatae* and the placing of Tina-

mous, next the Ostriches, since the above groups have been clung to with a pertinacity worthy a better cause, while the breastbone of the Tinamous has too often barred them from associating with their next of kin. It is also gratifying to read that the likeness of *Hesperornis* to the *Ratites* seems mainly to rest upon the degenerate structure of the wings and that it cannot be put down definitely as the ancestral form whence both grebes and divers have branched off. The author might perhaps have gone a little farther and said that the extreme specialization of *Hesperornis* seems to indicate that it represents one offshoot from the main stem which terminated then and there. The gulls are placed among the *Limicolæ*, but the auks are omitted, although this may strike some as showing undue partiality, while the placing of the Flamingo with the *Herodiones* will be commended by some and condemned by others. The balance of evidence, however, including some recent observations on the feathers, seems to lean towards the association here given, and this, like many other instances, may well serve to illustrate the difficulties that beset the classification of birds. In writing of the skull of woodpeckers the author apparently accepts the validity of the 'saurognathous' type, but, later on, in discussing the *Hesperornithes*, his allusions to 'the presumed vomers of the woodpeckers' shows that he does not feel quite convinced, and for our own part we agree with Shufeldt in considering the so-called vomers as purely adventitious ossifications. It may be here remarked that Mr. Beddard is preeminently fair in his discussion of all matters, the pros and cons of doubtful questions being impartially considered, the book being entirely free from any didactic tone.

It would have been well in defining the groups to have followed some uniform plan and, instead of setting down characters indiscriminately, to have, so far as possible, given the same characters, osteological, myological or cæcal, in the same order. This would have facilitated comparison and enabled any one to form a better estimate of the value of the various groups. But while we may differ from Mr. Beddard in the manner of using facts, we are

deeply indebted to him for the vast number he has placed at our disposal.

The mechanical execution of the book is excellent, the type clear and open, while the use of black-faced type for family names and of italics for anatomical characters is of great aid to the reader. The table of contents, however, is faulty, and it could be wished that the index was more than an index to species.

F. A. LUCAS.

Rivers of North America. A Reading Lesson for Students of Geography and Geology. By ISRAEL C. RUSSELL. New York, G. P. Putnam's Sons; London, John Murray. 1898. Pp. xix + 327. 17 plates, 1 table and 23 figures in the text.

The third volume in *The Science Series*, edited by Professor J. McK. Cattell, is the very welcome monograph by Professor Israel C. Russell, the full title of which is quoted above. In this, the fourth volume that Professor Russell has given us concerning the greater topographic forms of North America, we have a *treatise* that has long been needed for every-day use, particularly by those of us who are teachers. The particular serviceableness of the book, however, does not lie in the fact that Professor Russell has given us a single-volume reference book concerning American rivers, but because he first, in this country, has here presented a general consideration of the work, function and phenomena of rivers in general. Indeed, this volume is the best popular and yet scientific treatment we know of the origin and development of land forms, and we immediately adopted it as the best available text-book for a college course in physiography.

The nine chapters treat the many aspects of rivers and drainage in a logical, concise, clear and appealing manner, and, though in part they must be read closely, are very attractive to beginners because of the very apparent spirit in which the book was written. No beginner in earth science could gather from such a treatment the common conception that geography deals with 'dead things' only. The book is full of life and vigor, and shows the sympathetic touch of a man deeply in love with nature. As we expected such a naturalist's treatment, we turned

first in our reading to one of the later chapters, entitled 'The Life History of a River,' in which Professor Russell has given us a delightful summary of a river history as seen by a supposed being sufficiently long-lived to have outlived the river. In spite of the imagination demanded for the writing or reading, or perhaps better, because of the necessary imagination, the chapter in question is of exceptional value in emphasizing the comparative lives of man and earth forms, and the difficulty of gaining proper ideas of time. It is, however, a chapter that should be read as a summary and not as an introduction by a beginner; for a body of facts is necessary in order to have such a broad view properly understood and appreciated.

The plan of the book is very logical and practical, the first seven chapters being devoted to a careful account of the details of river work under the following larger headings: The Disintegration and Decay of Rocks, Laws Governing the Streams, Influence of Inequalities in the Hardness of Rocks on Riverside Scenery, Material Carried by Streams in Suspension and in Solution, Stream Deposits, Stream Terraces and Stream Development. The last two chapters are devoted to considering the more important American rivers, and the Life History of a River, in which a summary use is made of the principles that have been previously developed.

The first chapter is devoted to a consideration of the processes of mechanical and chemical disintegration and the consequences of such work, and forms a natural and necessary introduction to the especial treatment of rivers, which really begins in Chapter II. Here we find a good treatment of the processes and results of river erosion and transportation, and the important controls of such river work. Especial and perhaps a little too emphatic emphasis is given to the effect of the rotation of the earth upon river cutting, particularly as seen on Long Island. From such a forceful exposition of this control the beginner might unconsciously gather an erroneous impression of its importance in general.

The chapter devoted to the loads of rivers is very detailed and one of the most important of

the book. In spite of numerous analyses and tables, the text does not lose its interest, and the treatment is not above the ability of the average reader. The chapter is sufficiently inclusive for general needs, and yet free from the mathematical difficulties that scare the student so frequently in text-book considerations of this difficult subject.

In the consideration of river deposits the author gives a whole chapter to one group, namely, terraces, which, although of great interest, are not of such world-wide significance as the other greater groups considered together in Chapter V. In spite of this seeming divorce of related subjects, the arrangement is good, because the more normal conditions of river deposition can thus be considered in extenso, without too serious modification of the idea of a river's life cycle. We are glad to see the river deposits treated causally and inclusively. The consideration of deltas is particularly helpful and to the point. The classification is good, clear and workable, and one to be commended. The influences of climate, elevation and depression are treated at length, and the chapter closes with a summary devoted to the cross and longitudinal profiles of rivers illustrated with a few clear diagrams.

The most helpful chapter in the book is that devoted to stream development. Here we have for the first time available for public use the theory and the details of the newer classification of land forms. The questions of stream development and adjustment, the stages in river history and the topographic forms to be found in the various instances are considered concisely and clearly. The newer terminology is used with discretion and success. Only those terms that have to a certain extent been established by usage are included, and these are not given dogmatically in technical language. The author has not written his chapter to explain the terms to be found in the literature of his subject, as is so often the case, but has given each suggested term at the close of a clear exposition of a composite fact as a shorthand method of indicating the composite. The student reader of this chapter would not, we think, be led to use any term with quotation marks, either oral or written, but would avoid

a concise method of expression until his ideas were so clear that a short handle appealed to him, not as a possible, but as a necessary convenience. The chapter as a whole is a very serviceable text-book on modern physiography and is of exceptional value to all who have previously been embarrassed by the inaccessibility of the literature on this subject.

The footnote references are many and well selected, and, although not complete, give a good introduction to the general literature. The illustrations are, on the whole, excellent, and the form of reproduction has been unusually successful. The book could well have been enriched with more illustrations of normal river topography, and would then have been much more valuable, both to student and teacher. The typography is clear and pleasing, and the book very attractive in its general form. A good index completes the volume.

We read the book through almost at one sitting, and laid it down with but two regrets: first, that there was not more; and second, that this, the best of the series of four monographs by Professor Russell, was not uniform in general appearance with its predecessors. It is certainly a misfortune that three publishers should have issued these four books. Had they been uniform in appearance, they would have been of greater interest to the general reader, especially to those who get pleasure from the shelf as well as the hand appearance of a row of related books.

We know of but few books that are so nearly what one would desire as this book. Adverse criticism can only be directed to details, and lamentation over details is out of place when a book is so generally pleasing as this.

RICHARD E. DODGE.

TEACHERS COLLEGE, COLUMBIA UNIVERSITY.

Anatomy and Histology of the Mouth and Teeth.

By J. NORMAN BROOMELL, D. D. S. Philadelphia, P. Blakiston's Sons & Co. 1898. With 234 Illustrations. 8vo. Pp. viii + 428.

The book contains the best account of the teeth of man, which has yet appeared in the English language. It includes the treatment of oral anatomy and of dental histology and development. It is illustrated chiefly by original

photographs engraved in half-tone. The most important and most meritorious part of the book is comprised in Chapters VIII.-XI. (pages 131-280), which offer detailed and valuable descriptions of the teeth, marred only by a fantastic subdivision of the incisors, canines and first bicuspid of the upper jaw into four types, bilious, nervous, sanguineous and lymphatic, an astonishing revival this of mediæval pseudo-science in the midst of a work otherwise serious and intelligent. The author's descriptions are clear and admirable, and by their thoroughness meet a real need. In fact, it has long seemed singular that there should be no adequate detailed account of human teeth, but the need seems to be now well supplied.

The chapters on the teeth, above referred to, are preceded by the seven which deal with the anatomy of the oral region, and are followed by six chapters on the development of the teeth, the histology of oral structures and the histology of the teeth. Dr. Broomell's attempt to apply photography for histological illustrations is not encouraging, all of the figures of microscopic structure being very far inferior to cuts from drawings. The account of the development of the teeth is fairly good, but not equal to the standard of the anatomical part. Some minor errors appear in the embryological portions, for example, 'tooth band' is used instead of 'dental shelf'; the tooth germ in Fig. 180 is so distorted that it gives no idea of the true relations; in Fig. 181 the hole between the tooth and the shrunken enamel organ is labeled enamel. But it is not worth while to dwell upon these defects in a work of solid merit.

The publisher's share has been well executed, the general appearance of the volume being dignified and attractive, the printing excellent.

CHARLES S. MINOT.

BOOKS RECEIVED.

The Foundations of Zoology. WILLIAM KEITH BROOKS. Columbia University Biological Series. Vol. V. New York, The Macmillan Company. 1899. \$2.50.

The Native Tribes of Central Australia. BALDWIN SPENCER and F. J. GILEN. London and New York, The Macmillan Company. 1899. Pp. x + 671. \$6.50.

Die Spiele der Menschen. KARL GROOS. Jena, Gustav Fischer. 1899. Pp. iv + 538. Mark 10.

Zoological Results based on Material from New Britain, New Guinea, Loyalty Islands and Elsewhere, collected during the Years 1895-1897. ARTHUR WILLEY. Cambridge University Press. 1899. Pt. 2. Pp. 121-206. 12s. 6d.

Lectures on the Evolution of Plants. DOUGLAS HOUGHTON CAMPBELL. New York and London, The Macmillan Company. 1899. Pp. viii + 319. \$1.25.

Mental Arithmetic. J. A. McLELLAN and A. F. AMES. New York and London, The Macmillan Company. 1899. Pp. x + 138.

New York State Museum. Forty-ninth Annual Report of the Regents, 1895. Vol. 2, Report of State Geologist, Albany. University of the State of New York. 1898. Pp. 738.

Physical Chemistry for Beginners. DR. CH. VAN DERVENTER. With an Introduction by PROFESSOR J. H. VAN'T HOFF. Translated by BERTRAM B. BOTHROW. New York, John Wiley & Sons; London, Chapman & Co. 1899. Pp. x + 154. \$1.50.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *Auk* for January is an unusually large number, and consequently is a little late in making its appearance. It commences with Mr. Chapman's discussion of the 'Relationships of *Ammodramus maritimus* and its Allies,' which is followed by Mr. O. B. Warren's 'Chapter in the Life History of the Canada Jay.' Mr. Oberholser has a paper on 'The Blue Honey-Creepers of Tropical America,' for which the new generic name *Cyanerpes* is proposed, and Dr. Gill considers the generic names *Pediocætes* and *Poocætes*, concluding that they must give way to *Pedioecetes* and *Poocetes*. Many new species and subspecies are described, a New *Hylocichla* by Mr. Oberholser, a number of new forms from Mexico by Mr. Nelson, and several new species and subspecies of N. A. *Fringillidæ* by Mr. Ridgway. Under the caption 'Truth versus Error,' Mr. Elliot and Dr. Allen continue the discussion of the propriety of correcting mis-spelled scientific names. Mr. Witmer Stone presents a long report, very encouraging in parts, on 'The Protection of North American Birds,' and, -finally, is the Ninth Supplement to the A. O. U. Check List. This contains a long list of

changes, the most startling of which, perhaps, is at the outset, where the generic name for the Loons is decided to be *Gavia* and the family name *Gaviidæ*.

THE contents of *The American Journal of Science* for February are as follows:

'Contribution to the Study of Contact Metamorphism,' by J. M. Clements.

'Origin of Mammals,' by H. F. Osborn.

'Chemical Composition of Tourmaline,' by S. L. Penfield and H. W. Foote.

'Littoral Mollusks from Cape Fairweather, Patagonia,' by H. A. Pillsbury.

'Thermodynamic Relations for Steam,' by G. P. Starkweather.

'Descriptions of imperfectly known and new Aotianians, with critical notes on other species, III,' by A. E. Verrill.

'Volumetric Method for the Estimation of Boric Acid,' by L. C. Jones.

SOCIETIES AND ACADEMIES.

THE TEXAS ACADEMY OF SCIENCES.

THE midwinter meeting of the Texas Academy of Science was held in Austin during the last week of December. The program was as follows:

Tuesday, December 27th.—(1) 'Do the Reactions of the Lower Animals due to Injury indicate Pain Sensations?' Professor W. W. Norman, University of Texas. Numerous experiments upon living animals were described in detail and the conclusion reached that so far as the invertebrates and the lower vertebrates are concerned the reactions due to injury do not necessarily indicate pain. (2) 'Three Recent Gifts to the University of Texas,' Dr. W. J. Battle. The gifts described in this paper consisted of, 1st, a storage amphora from the cellar of the Courts of Justinian in Constantinople; 2d, a stone bearing an inscription recording the gift of a crown to one Lysagoras by the people of Ilium, and 3d, a twelfth century manuscript of the Gospels from the Island of Prinkipos, Sea of Marmora. These interesting objects were presented to the University by the Hon. Alexander Terrell, late Minister of the United States to Turkey.

Wednesday, December 28th.—(1) 'Some New Measurements of Electric Waves,' Regent R. S. Hyer, Southwestern University. This valu-

able paper is already in the hands of the printer and will soon be ready for distribution. (2) 'Variations of Indian Corn when brought from New York to Texas,' Professor H. Ness, Agricultural and Mechanical College of Texas. The experiments here described were begun in 1896 at the suggestion of Professor L. H. Bailey, of Cornell University. Corn, of the same varieties, was planted at Ithaca, New York, and College Station, Texas; comparative notes taken, and the results carefully tabulated. (3) 'An Analysis of the Factors determining the Geographical Distribution of Plants in Texas' (read by title), Dr. William L. Bray, University of Texas. (4) 'Note on the Descent of Erythronium Bulbs into the Soil,' Professor O. C. Charlton, Baylor University. (5) 'A Review of Bulletin, No. 151, of the United States Geological Survey,' 'The Lower Cretaceous Gryphæas of the Texas Region,' by Robert T. Hill and T. Wayland Vaughan, Dr. Frederic W. Simonds, University of Texas.

The recent publications of the Academy are: 'Applications of Non-Euclidean Geometry,' by Dr. George Bruce Halsted; Address before the Academy, by President L. S. Ross; 'The Essential Differences between Man and Other Animals,' by Dr. S. E. Mezes; 'Pedagogical Notes on Mensuration,' by Arthur Lefevre, C.E.; 'Science and the State,' by the President of the Academy, Professor T. U. Taylor.

FREDERIC W. SIMONDS.

PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 494th meeting of the Society was held January 21st, at 8 p. m., at the Cosmos Club. An informal communication of an exceedingly interesting character was given by Surgeon-General Sternberg on Radiographs, accompanied by the exhibition of some remarkable photographs by the X-Rays. The first regular paper was by Dr. L. A. Bauer (read by Mr. J. F. Hayford, of the Coast and Geodetic Survey), the subject being 'The Decomposition of the Earth's Permanent Magnetic Field.' This paper was an attempt to resolve the Earth's permanent magnetic field into component ones physically interpretable. The normal distribution of the Earth's magnetism is defined as that which can be regarded as resulting from a uniform magnetization about

a diameter inclined to the rotation axis. The normal magnetic components (northerly, easterly and vertical) are next computed for 1800 points on the Earth's surface between parallels 60° N. and 60° S. These are then subtracted from the observed values and thus the residual components are obtained. With the aid of these is mapped out that portion of the Earth's magnetism which cannot be referred to a uniform magnetization (or to equivalent effects) about a diameter inclined to the Earth's axis. The residual field consists mainly of two transverse magnetizations, one magnetic system lying in the northern hemisphere, the north end attracting pole being east of the south end attracting pole, and the second system lying in the southern hemisphere, the direction of magnetization being the reverse of the former. Striking coincidences manifest themselves between the characteristics of the residual field and those of the diurnal variation field as determined by Schuster. The foci of both fields lie near parallels 40° (N. and S.) As the author is conducting other related investigations, he refrains from drawing definite conclusions until these investigations have been completed. The second paper was by Mr. C. F. Marvin and was a description of the apparatus employed at several Weather Bureau stations during the past summer for the purpose of making a preliminary survey of meteorological conditions in the upper air. The results obtained from these investigations are now being classified and worked up. A special form of Hargrave cellular kite was employed and controlled in flight from a convenient form of hand windlass. The automatic records were obtained by means of a special kite meteorograph, of the author's design, and adapted to record the temperature, pressure and humidity of the air and wind velocity. The meteorograph was attached firmly to the kite. Its weight, complete, was 2.1 pounds; that of the kite, about 8 pounds.

E. D. PRESTON,
Secretary.

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON.

THE 284th regular meeting of the Anthropological Society was held Tuesday evening, Jan-

uary 3, 1899. The members of the Woman's Anthropological Society were elected to membership in the Society, the former Society as a body being absorbed by the Anthropological Society. Miss Alice Fletcher read a paper on 'A Pawnee Ritual,' in which she laid stress upon the fact that a literal translation of the ritual did not convey the true meaning, did not express the poetic thoughts or the real philosophy of the ritual, and these could only be obtained by a free translation, based upon an intimate knowledge of the Indian's picturesque and poetic expression of his thoughts.

Mr. Francis La Flesche sang a part of the ritual, to show the manner in which the Priest rendered it.

Discussed by Mr. Cushing.

Mr. W. H. Holmes read a paper on 'One Step in the Evolution of the Maya Temple.' Mr. Holmes described the remarkable edifices the ruins of which are found in numerous ancient cities of the Maya territory, and dwelt briefly upon their origin and development, but the chief object of the paper was to indicate the very pronounced influence of the corbelled arch, sometimes called the Maya arch, on the buildings. Without stopping to discuss the question as to whether the suggestion of this method of spanning chamber spaces came from within or without the Maya province, the manner in which it would probably supplant the horizontal beam of wood or the slab of stone was pointed out. Offsetting the upper stones of a wall enabled the builder to span the space with shorter beams or stones and led finally to the exclusive use of stone, a great step in the direction of permanency. The effect of the arch upon the chambers was to widen them considerably and greatly to increase their height; but the most remarkable result was exterior, as the height was more than doubled. The doorways were not changed, however, and the original façade remained the same, being limited above by a heavy cornice representing the ends of the horizontal beams or eaves of the early period. The added upper wall, carried up vertically in Yucatan and at a high angle in more southern sections, was devoted entirely to ornament and became the most remarkable feature of the structures, affording the builders

no end of opportunities for displaying their genius for sculpture and their devotion to symbolism.

Discussed by Messrs. Cushing and McGee.

J. H. McCORMICK,
Secretary.

THE NEW YORK ACADEMY OF SCIENCES—SECTION OF PSYCHOLOGY AND ANTHROPOLOGY, JANUARY 23.

THERE was an unusually good attendance at the regular meeting of the Section. From the psychologists there were papers by Chas. H. Judd, of New York University, on 'The Visual Perception of Linear Distances;' by B. B. Breese, of Columbia, on 'Some Experiments in the Voluntary Control of Retinal Rivalry,' and by C. B. Bliss, on 'A Modification of one of the Psychophysical Methods.'

On the part of the anthropologists there was a brief report by the returning members of the expedition sent out by the American Museum of Natural History to study the Gilliak tribes of eastern Asia. A paper was then read by A. Hrdlicka, of the Museum, giving the result of a study of the custom of painting bones.

Two other papers on anthropology contained in the program went over to the next meeting for lack of time.

C. B. BLISS,
Secretary.

SECTION OF ASTRONOMY AND PHYSICS—JANUARY 2, 1899.

THE section was called to order by Chairman Dudley, 19 persons being present. In the absence of the Secretary, Mr. T. G. White was elected Secretary *pro tem*.

The first paper of the evening was by Professor Wm. Hallock, printed on page 210.

In the discussion which followed, Professor D. W. Hering suggested connecting the string or spiral by which impulses are imparted to the ring, to a tuning fork, the rate of vibration of which could be regulated by weighing and which could be operated electrically, for reciprocating motion of small amplitude and of a known rate.

The second paper was by Dr. F. L. Tufts on the 'Absorption and reflection of sound waves

by porous materials.' This paper gave the results of experiments on the transmission and reflection of sound by such materials as flour, sand, sawdust, shot and a few different kinds of cloths. It was stated that when sound waves strike against materials pervious to air they act very much like a pneumatic pressure, and that the amount of sand transmitted through such materials is inversely proportional to the resistance offered by the materials to the passage of a direct current of air. The results of the experiments upon the reflection of sound from the same materials showed that those materials that transmitted the greatest amount of sound reflected the least. The paper also contained an account of some experiments in which the sound waves had to pass through some pervious material, such as the curtains upon a wall, and were then reflected back through the same by the impervious wall.

In the discussion that followed the reading of the paper Professor Hallock suggested the practical application to the improvement of the acoustics of rooms which might result from these investigations, and the futility of the method of string wires in large halls to break up echoes, which had been often advised, but which was disproved by these experiments. Mr. Dudley also spoke of the attempts that had been made to obtain materials absorptive of sound, to deaden the noise in railroad cars.

The third paper was by Mr. P. H. Dudley, on 'Translative curves of counter balance and crank pins in running locomotives.' It was profusely illustrated by lantern views of locomotives in the various positions described. These showed the loci of the center of gravity of the counter weights, crank pins and driving axles in running locomotives. Some of the photographs showed the position of the counter weights in the driving wheels of running locomotives in reference to the stremmatograph under the rail. The counter weights added to the driving wheels to balance the reciprocating parts, crank pins, main and side connecting rods, when the engine is running, besides rotating around the axles, move along the rails per revolution a distance equal to the circumference of the drivers. The locus of the center of gravity of the counter weights six inches from

the tread of the tire in a seven-foot driving wheel travels above the locus of the driving axle more than three times as far as it does below. The locus of the center of gravity of the crank pin for 24-inch stroke of piston in a driving wheel of 7-foot diameter travels 44 per cent. more above the locus of the driving axle than below it.

The above cited facts show that the relative velocities of the center of gravity of the counter weights and crank pins are not constant for each portion of a revolution as in the stationary engine, but are unequal and constantly changing. Therefore, the forces generated are unequal, and perfect counter balance does not obtain in the locomotive. Part of the unbalanced forces must be absorbed by the locomotive itself and part by the permanent way. The upper portion of the driving wheel moves much faster than the lower portion running on and in contact with the rail, in striking contrast to the uniform velocity of the rim of the fly wheel of a stationary engine.

Dr. Dudley also showed lantern views of running locomotives, in which the lower spokes of the driving wheels were sharply defined, while the upper ones, running so much faster, were not stopped for the same exposure.

REGINALD GORDON,
Secretary.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

At the meeting of the Academy of Science of St. Louis of January 23, 1899, a paper by Professor A. S. Hitchcock, entitled 'Studies on Subterranean Organs, Part I, Compositæ of the vicinity of Manhattan, Kansas,' dealing with the structure of a number of rootstocks with reference to their environment, was presented in abstract. Mr. C. H. Thompson also spoke of some plants the flowers of which originate endogenously. He mentioned several species of *Rhipsalis* in which the much reduced leaves grow on triangular or cylindrical very succulent stems, their axillary buds originating deep down in the soft tissue and sometimes having a passage-way extending toward the surface. In two species of *Rhipsalis* (*R. paradoxa* and *R. floccosa*) there is no such passage-way, and the bud, in developing, breaks

through the epidermis. In *Rhipsalis glauca* a number of accessory abortive flowers were found. *Cuscuta glomerata* was mentioned as the only other plant in which, so far as the speaker knew, subepidermal flowers occur.

One person was elected to active membership.

WILLIAM TRELEASE,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

ZOOLOGICAL NOMENCLATURE.

EDITOR OF SCIENCE: I fear that the subject may verge on becoming tedious to your readers, but will ask the privilege of concluding my part in the discussion by a few comments on two points raised in Mr. Bather's communication of January 10th (p. 154).

It will hardly be denied that the date of printing will always be useful to the systematist in noting a period earlier than which publication of a paper *cannot* be claimed, even if we ignore the obvious fact that in nearly every case it will now-a-days closely approach the date of distribution or actual publication. Hence, the committee should consider well before minimizing its value.

Secondly, it has been held, with some plausibility, that the distribution by favor alone should not constitute publication, but that the ability of any one interested to procure a paper by purchase is essential to an effective publication. If now, by a doctrine of ethics which is certainly novel to me, the committee decides that no paper can be regarded as published until the society which prints it is ready to sell the complete volume of which it may form a part, it is obvious that the committee has it in contemplation to put a quietus on the prompt publication of separate papers, unless this is done commercially by the society in question, in the first place. To this proposition I believe it will be impossible to obtain the assent of workers in systematic natural history, and justly so.

The reasons are obvious and need not be enlarged upon. I think it is not unfair to add that most libraries in this country would rather pride themselves on procuring, even at the cost of seven shillings, at the earliest practicable

moment, a paper demanded by their readers; and would consider its belated acquisition in the miscellaneous volume of a scientific society, subsequently, as no reflection upon their performance of their duties to the public.

WM. H. DALL.

THE RED-BEDS OF KANSAS.

THE correlation of the Red-Beds of Kansas has hitherto been impossible to satisfactorily settle, as has been stated by Professor Prosser in his admirable report upon them in the second volume of the University Geological Survey of Kansas. Many persons have diligently sought for fossils in them, but entirely without success until recently. About two years ago Mr. C. N. Gould discovered a horizon just south of the Kansas line and at the base of the Kansas series, containing large numbers of a small phyllopod crustacean, examples of which, when referred to Professor T. Rupert Jones, through Professor Prosser, were determined as *Estheria minuta* with some doubt, as stated in his paper in the *Geological Magazine* (1898, p. 291).

Associated with these crustacean remains, the blocks sent with the skeleton showing numerous specimens, was a large part of the skeleton of an amphibian. This specimen is now in the University of Kansas collection, but so far has been only partly freed from its matrix, a work of much tediousness. The parts already brought to light, however, enable me to determine it as *Eryops megacephalus* Cope, a form described from the 'Permian' of Texas.

This identification settles once for all the horizon whence it came as Permian, if the Texas beds be really of that age. There are several hundred feet of deposits in Kansas above this horizon that still possibly may be considered as Triassic, but there is no reason for so doing. *Estheria minuta* is a Triassic species, but, even if correctly determined, its value is slight in comparison with that of the vertebrate in the correlation of the beds. It must be remembered, however, that *Eryops* is by no means necessarily characteristic of the Permian.

S. W. WILLISTON.

MEN OF SCIENCE AND ANTI-VIVISECTION.

IF, according to my critic (SCIENCE, Dec. 16, 1898, p. 873), the efforts of the anti-vivisection-

ists are to be regarded as antics, or as the idiotic spot upon the brain of many people, the writer lacked wisdom in urging that men of science, thus far only cognizant at second hand of the points at issue, should divest themselves of the bias of *esprit-de-corps*, and, emerging from the influences exerted upon them by a sub-division of their colleagues, decide, through their own investigation, for or against experiments on living animals.

In the writer's opinion, however, not fully expressed in the number of *SCIENCE* referred to, the adequate hearing, which has not been, should be given to the allegations of the anti-vivisectionists, namely: (1) That the experiments have not helped medical or scientific knowledge. (2) That the experiments are not properly restrained, and can be pursued in the United States not only by scientific men, but by tyros, or by others in an undue, excessive and superficial manner. (3) That whether to the advantage of scientific knowledge or not, the practice of painful experiment on unwilling living creatures, by a human mind aware of the significance of pain upon the higher animals, is an act founded on no right and degrading to that human mind.

In the latter allegation, passing by here the two preceding it, the writer sees the real issue. Denying such tendency of the experiment on the experimenter, seeming willing to leave to the latter his present unrestricted latitude, the advocate of vivisection, apparently under sanction of the National Academy of Sciences, asserts not only an excuse, but a right for the experiments in their alleged advantage to science and the human race.

This is to fortify the practice in one of the strongest ways possible, since the thought trend of the human majority makes naturally toward a magnification of its own successes, and a justification of the latter even when demonstrably achieved at the expense of insignificant and unvoiced suffering. The right of communities to advantage (amuse) themselves by human pain still exists among certain savage and barbarous peoples. The right of nations, proceeding, for their own alleged advantage, to practice felony and murder (according to their rule laid down for individuals), to act frequently upon the

abused precepts of Machiavelli, while proclaiming Christianity, is not potently questioned throughout Christendom, while the notion of restraining the alleged rights of civilized communities and individuals to advantage (amuse) themselves by the infliction of great pain on lower forms of life has entered the heads of but few of those thus advantaged. Nevertheless, some ameliorations have been made in certain cases towards the alleviation of the pain, which has been supposed to confer the benefit upon its inflictor, and the attempt of the human friend of animals, in this instance, to set limits to the gains of humanity is not more unreasonable than the existence of certain limits already set by humanity itself to its own gains.

When human public opinion forbids by law the practice of forcible vivisection upon a felon condemned to death, it limits the advance of scientific knowledge by ruling off the dissecting table a class of fiber and tissue more valuable for medical study, while not demonstrably more significant to the community, than the fiber and tissue of a dog. If we forbid the hypnotist to learn by experiment upon the human subject, whether the latter can be mesmerically influenced to steal, commit adultery, lie, or otherwise yield to inborn passions, we again obstruct science. When society denies the right of doctors to test theories and modes of treatment, or to advance scientific knowledge, by occasionally killing or paining moribund human patients in hospitals, it retards scientific knowledge by limiting a class of experiment more valuable to the experimenter than similar inflictions by analogy upon animals. At the same time the restraint acts upon a principle no more logical, no less so, than that which moves the anti-vivisectionist.

But in its deeper sense the late movement in defense of animals justifies itself not in logic, which has not yet solved the mystery of pain, torture and death, but rather in the expansion of the very potent principle of love or sympathy.

Raising clearly and fully a momentous question which, it is to be regretted, *Science* did not honor herself by raising for them, the defenders of animals proclaim that the whole question of the ravages of *Homo sapiens* (who seems to have

lost touch with fellow animals somewhere in the stone or bronze age, *since which time he has ceased to domesticate them*) upon the lower forms of life needs revision; that many of the ravages are unjust; nay cruel and degrading; that in many cases they should be ameliorated through human education, while in other indefensible instances they should be abolished by human law.

In this agitation the observer of humanity, from the widening point of view of anthropological science, sees not a fanatical outburst, but an extension of one of the potent familiar factors of human development, an evolution of the ancient and ever-growing protest against the alleged right of extreme might, constituting itself the judge, whether as populace or despot, priest or tyrant, egotist or felon, science or creed, to forcibly inflict pain upon insignificant or helpless victims.

Science, since Darwin at least, admits no such chasm as theology formally alleged, between animals and man, while, with the wider study of nature, the attitude of mind which has previously circumscribed the activity of human redress to human ills fades away.

It is the effort which affected the abolition of gladiatorial combats, burnings at the stake, torture chambers, the Inquisition, serfdom, the abatement of slavery and the persecution of Jews, which is now seen to expand. Long limited in sympathy to the groans of man, it is now led, by the power of expanding knowledge, to listen to the cry of man's speechless victim, the tortured brute.

Suddenly and strangely, at the close of the nineteenth century, we mark, throughout civilized peoples, the uprising of societies and individuals who, again rejuvenating the thought of Buddha, appear unselfishly to strive to extend human sympathy beyond the human barrier. But the outgrowths are not spontaneous. It is because of one of the most potent of the forces which has led man from darkness toward civilization that they exist. It is because of a principle that should be dear to the heart of a man of science, and for which Science herself has suffered, that the idea of the human being advancing his own knowledge by acts so selfish as vivisection meets with self-condemnation.

Flint (*Text-book of Physiology*) frequently exposing the nerve roots of dogs in public demonstrations; Castex (*Archives Gen. de Medicine*, Jan. and Feb., 1892) clubbing out of joint the shoulders of unnarcotized dogs to show how to massage them; B. A. Watson (*Experimental Study of lesions arising from severe concussion*, 1890) dropping living dogs from heights so as to produce and then study on them concussion of the spine; cutting the intestines of living dogs and then sewing the ends together with dull needles in certain ways, to study circular sutures; Phelps' fixing the joints of living dogs in cramped positions for six weeks and five months, to see if ankylosis would ensue; Porter (*Journal of Physiologists*, April 6, 1895) exposing for its entire length the cervical cord of a narcotized dog and severing it at the sixth cervical vertebra; seizing the phrenic nerve of thirteen lightly narcotized dogs and rabbits and tearing it out of the chest; studying respiration (Report Royal Humane Society, 1865, pp. 31-66) by plunging the heads of seventy-six living animals in liquid plaster-of-paris until suffocation ensued by the hardening of the plaster in the bronchial tubes in four minutes; Chauveau (Wilberforce to the *Zoologist*, London, July, 1892) studying excitement of spinal marrow upon eighty living horses and asses by chiseling open the vertebræ and exposing the marrow; washing out parts of the brains of living dogs and studying their future action in subsequent days or weeks (Pfluger' *Archives*, 1888, p. 308). These are acts which, when known in the light of widening sympathy, gradually become intolerable to the human mind.

HENRY C. MERCER.

SECTION OF AMERICAN AND PREHISTORIC ARCHAEOLOGY AT THE UNIVERSITY OF PENNSYLVANIA, January 9, 1899.

[It is desirable for this JOURNAL to admit discussion of scientific questions, however little the point of view may commend itself to most men of science. Mr. Mercer states that the anti-vivisection movement does not justify itself in logic, and hence argument seems somewhat futile. If any of our readers are influenced by Mr. Mercer's remarks we recommend them

first to try to verify the references given at the end, in which they will fail, and second to read 'Vivisection: a statement in behalf of Science,' published in the issue of this JOURNAL for March 20, 1896, and endorsed by President Eliot, of Harvard University, and the late Francis A. Walker, President of the Massachusetts Institute of Technology.—ED. SCIENCE.]

ASTRONOMICAL NOTES.

REPORTS OF OBSERVATORIES.

THE annual reports of three of the most active observatories of the world are at hand.

1. *Report of Her Majesty's Astronomer at the Cape of Good Hope for the year 1897.*—The astrophotographic telescope was used for chart plates, catalogue plates, variables, and with a 20-degree prism for a spectroscopic survey of stars to $3\frac{1}{2}$ magnitude. The transit circle was used for stars needed for the measurement of plates to complete the Cape zones, -40° to -52° . 9,000 standard stars will be included in this area. The 7-inch equatorial has been chiefly used to look up discrepancies in the photographic plates and in checking missing stars. Among the results obtained was the confirmation of the large proper motion of $9''$ in the star which Kapteyn had detected on the plates. The heliometer was used chiefly in triangulation of comparison stars for observations of planets at opposition. Preparations were making for the mounting of the new McLean telescope, constructed by Grubb, and the new transit circle by Troughton and Simms. The computations were chiefly upon the meridian observations of former years, and upon heliometer observations for parallax. Dr. Gill has eleven regular assistants and computers, with other computers occasionally employed. The observatory carries on an extensive system of time signals, and the geodetic survey of South Africa will be under the direction of the government astronomer.

2. *Report of the Superintendent of the U. S. Naval Observatory for the year ending June 30, 1898.*—The 26-inch equatorial has been used for micrometric observations of the faint comets, satellites, close doubles and the diameters of

Venus and Mercury. The 12-inch telescope has been similarly used for asteroids and comets. The 9-inch transit has been used for sun, moon, planets and certain stars. The new 6-inch steel transit is in process of erection. The 5-inch altazimuth has been used as a zenith telescope and as a vertical circle. The opinion is expressed that declinations can be obtained with greater accuracy by this instrument than by a meridian circle. The astronomical work has been materially lessened by the detachment of line officers for active service in the recent war, necessitating the care of nautical instruments, chronometers and time service by the astronomical staff. This report goes into minute detail regarding the work of the Observatory, even mentioning such minor matters as the mounting of a new thermometer, and the repairing of the wooden cases of clocks, the glue in which had deteriorated. The Nautical Almanac has been under the care of the Astronomical Director, Professor Harkness. The chief publication has been the Catalogue of Stars from observations made from 1866–1891, prepared by Professor Eastman.

3. *Fifty-third annual report of the Director of the Astronomical Observatory of Harvard College, for year ending September 30, 1898.*—The 15-inch equatorial has been used for photometric observations chiefly of variables. The 6-inch equatorial has been used for observations of variables by the method of eye estimates. The meridian circle has been used to complete the observations for the southern zone— $9^\circ 50'$ to $-14^\circ 10'$. The meridian photometer has been devoted to the reobservation of the stars in the Harvard Photometry and other stars fainter than those in that catalogue. The 8-inch and 11-inch photographic telescope, working under the Henry Draper Memorial, have obtained more than 3,000 plates. Their study has resulted in various discoveries, such as twelve variables, stars of peculiar spectra, one spectroscopic binary, one spectrum of a meteor with five bright lines, one spectrum of the aurora with four bright lines. At Arequipa, Peru, more than 2,400 plates have been made with the 8-inch, 13-inch and 24-inch telescopes. Professor Bailey's study of variables in clusters has revealed 509 variables in 20 clusters; the light

curves of 125 variables in ω Centauri have been obtained.

Among other matters discussed by Professor Pickering in his report is the organization of the Observatory. The Harvard College Observatory is not, like many other observatories, divided into departments each under an astronomer of high grade. The Director himself is in immediate charge of all the departments, in many cases making a daily inspection and planning the work in detail. The assistants become skillful each in a particular work, and three or four times as many can be employed at a given expenditure as under the departmental system. The report mentions the advantages and disadvantages of each plan and advises that the plan in operation at Harvard should continue to be followed in one large observatory. The corps of assistants at Harvard and at the Southern Station, in Peru, includes forty persons.

THE PLANET DQ.

THIS planet has been named *Eros*. The *Astronomical Journal* and Circular 36 of the Harvard Observatory contain the gratifying announcement that numerous observations of the planet have been found on the Harvard plates in 1894 and 1896. In 1894 the planet was at its most favorable position for observation, and of the 7th magnitude when nearest. Observations have been found extending for more than four months, making it possible to determine an accurate orbit for that opposition alone. Dr. Chandler has undertaken the rigid discussion of all available data, and will bring the calculation down to the 1900 opposition, so that the observations then to be made will be under the best knowledge of the theory of the planet's motion.

This research has justified the policy of Professor Pickering in having the whole sky photographed at frequent intervals. That the plates thus accumulating contain a vast amount of material which the future needs of astronomy will utilize is quite evident. That many new facts can be obtained from their examination is shown by the discovery during the search for the planet *Eros* of two variables and two stars which are not in the *Durchmusterung* catalogue,

besides observations of asteroids previously discovered.

WINSLOW UPTON.

BROWN UNIVERSITY, January 27, 1899.

NOTES ON PHYSICS.

SOME RECENT INVESTIGATIONS UPON THE BECQUEREL RAYS.

RUTHERFORD (*Phil. Mag.*, Jan., 1899), in an important and interesting paper, shows experimentally that in a mass of gas exposed to the radiation from uranium, thorium or their compounds the following statements hold good:

1. Charged carriers produced through the volume of gas.
2. Ionization proportional to the intensity of the radiation and the pressure.
3. Absorption of the radiation proportional to pressure.
4. Existence of a saturation current; i. e., a current passing through the ionized gas, whose magnitude is such that all of the carriers produced by the radiation reach the electrodes.
5. Rate of combination of the ions proportional to the square of the number present.
6. Partial separation of positive and negative ions.
7. Disturbance of potential gradient under certain conditions between two plates exposed to the radiation.

It is also shown that the radiation given off by both uranium and thorium is complex, consisting of two varieties which the author calls α and β respectively; β being the one of greater penetrative power, while α is the one chiefly instrumental in causing ionization in gases. The intensity of the α radiation seems to depend chiefly upon the amount of surface of the uranium, while the β radiation depends upon the thickness of the layer.

In *Wied. Ann.*, No. 12, for 1898, Elster and Geitel give an account of a research undertaken by them to test the validity of two suppositions which have been made as to the cause of the Becquerel rays. Madame Curie (*Comptes Rendus*, CXVI., p. 1101) has suggested that the continuous radiation from uranium, thorium and their compounds may be explained by supposing all space to be filled with a sort of modified Röntgen radiation which possesses the power

of penetrating ordinary media to a much higher degree than the usual X-rays, and that in attempting to traverse substances having high atomic weights, like uranium and thorium, a portion of the incident energy is transformed into radiation having the power of affecting photographic plates, ionizing gases, etc. Elster and Geitel have tested this by examining the intensity of the uranium radiation by both the electrical and photographic methods, the apparatus being placed first upon the surface of the earth and then several hundred meters underground in a mine, their idea being that the intensity of the radiation incident upon the uranium would be weakened by passing through the overlying mass of earth. No difference was found in the intensity of the uranium radiations under the two conditions.

To test the hypothesis of Crookes as to the radiation being caused by a transformation by the uranium of a portion of the kinetic energy of the molecules of air, the intensity of the radiation emitted by the uranium when in a vacuum was compared with that emitted when the metal was in the air. No difference was found.

The results of this work are hence unfavorable to either hypothesis.

M. and Mme. Curie have shown (*Comptes Rendus*, CXXVII., p. 175) that in pitchblende there is a substance similar in properties to bismuth, but which is strongly radio-active, and for it they have proposed the name Polonium. In *Comptes Rendus*, CXXVII., p. 1255, they give an account of their more recent researches in which they have been associated with M. G. Bémont upon this subject. They are led to the conclusion that there is still another new substance present, similar in properties to pure barium, but whose chloride is about nine hundred times as active as that of uranium. The new substance, provisionally called Radium, is distinguished by a hitherto unknown line in its spectrum.

A. ST. C. D.

BOTANICAL NOTES.

SARGENT'S SILVA OF NORTH AMERICA.

THE appearance of Volume XII. of this magnificent work again directs attention to what

will, for all time, be a monument to both author and publishers. Eight years ago the first volume appeared, and at more or less regular intervals the succeeding volumes, until the present one, which was originally designed to be the last. In these volumes we have 620 plates, thus more than making good the promise of author and publishers of fifty plates per volume. We have now the pleasant announcement by the publishers that, "as it has been found impracticable to include in this twelfth volume of Professor Sargent's great work the general index to the entire work, a thirteenth volume containing this index, together with descriptions and illustrations of recently discovered species, and such corrections of the original volumes as recent explorations have made necessary will be sent to subscribers without change as soon as ready."

The present volume includes descriptions and plates of *Larix* (3 species), *Picea* (7 species), *Tsuga* (4 species), *Pseudotsuga* (2 species) and *Abies* (10 species). We shall look with great interest for the appearance of the supplementary volume.

COMMENDABLE FREE-SEED DISTRIBUTION.

AT last the United States Department of Agriculture has made a free distribution of seeds, which must commend itself to every scientific botanist or horticulturist in the country. We refer to the distribution to colleges of the sets of 'Economic Seeds,' prepared in the Seed Laboratory of the Division of Botany, by the lamented Gilbert H. Hicks, under the direction of Frederick V. Coville. The set as issued consists of five centuries, each enclosed in a shallow tray-like box, which is divided into rectangular spaces, each large enough to contain the seed-tubes. Each tube is numbered and labeled, and on the lid of the tray is an alphabetical list of all the species arranged under their appropriate families. It is a pleasure to note, moreover, that the most scrupulous care has been taken to secure accuracy in the nomenclature, which is of the strictly modern school, including double citation of authors and the uniform decapitalization of specific names. This distribution is a worthy and commendable labor of the National Department of Agriculture, and it reflects great credit upon the officers

who are responsible for its inception and successful execution.

THE STUDY OF IOWA SEDGES.

IN a recent bulletin of the Laboratories of Natural History of the State University of Iowa, Mr. R. I. Cratty contributes a valuable paper upon the sedges of Iowa.

The list includes the results of about thirty years of work by Iowa botanists, and brings together data relating to ten genera and one hundred and fourteen species. With regard to the nature of the sedge flora of Iowa, the author says that it is "characteristically Eastern and corresponds quite closely with that of the bordering States, and, though lying just east of the Great Plains, but one species, *Carex stenophylla* Wahl., has yet been found which does not occur east of the Mississippi River. The richest portion of the State in sedges is that bordering on this great waterway. This may be accounted for partly because of the greater diversity of soil, surface, woodland and prairie in that region, and partly because the natural agencies for the distribution of seeds and the greater rainfall combine to favor that portion of the State."

NORTH AMERICAN SEAWEEDS.

WITH the distribution of the eleventh fascicle of *Phytotheca Boreali-Americana* by Messrs. Collins, Holden and Setchell there comes the announcement of a new series, to consist of larger specimens, including such plants as *Nereocystis*, *Laminaria*, *Fucus*, *Agarum*, *Dictyonereis*, etc. The fascicles of this series will be designated by letters, A, B, C, etc., and the specimens numbered with Roman numerals, I, II, III, etc., so as to avoid confusion with the other series. Moreover, the fascicles of the new series will contain twenty-five numbers each, instead of fifty, as in the old series. There will thus be two series running side by side, and the announcement is made that either one may be subscribed for separately or both may be taken simultaneously.

ARTHUR AND HOLWAY'S RUSTS.

FOUR years ago Dr. J. C. Arthur and Mr. E. W. D. Holway issued fascicle I of a distribution of specimens and figures of the Rusts under the

title 'Uredines Exsiccatae et Icones.' A few days ago the second fascicle was received, and it is so noteworthy as to call for a word here. It contains fifty-two packets of specimens, each accompanied by enlarged drawings of the spores, and in addition thirteen photomicrographs taken directly from prepared slides. When we remember that this fascicle is sent to subscribers for three dollars we may realize that it is entirely a labor of love. Its value to students of the Rusts is incalculable.

CHARLES E. BESSEY.

THE UNIVERSITY OF NEBRASKA.

CURRENT NOTES ON ANTHROPOLOGY.

COURSES AT THE ÉCOLE D'ANTHROPOLOGIE.

THE following courses, public and gratuitous, are given this winter at the School of Anthropology, Paris: (1) Prehistoric anthropology: its general principles and methods (Professor Capitan). (2) Zoological anthropology: Origin of man (Professor Mahoudeau). (3) Ethnography and Linguistics: French language and culture in the 12th and 13th centuries (Professor Lefèvre). (4) Ethnology: The Basques and Aquitanians (Professor Hervé). (5) Biological Anthropology: The struggle for life (Professor Laborde). (6) Anthropological Geography: America (Professor Schrader). (7) Physiological Anthropology: The sexes (Professor Manouvrier). (8) Sociology: China (Professor Letourneau). An extra course on North Africa will be given by Professor Zaborowski. There are two lectures a day on five days of the week.

THE MEANING OF 'RACE.'

THAT much abused word, 'race,' has been the stumbling-block of many writers. Anthropologists try to make it a zoological term, connoting certain identical physical features. How far this is from general acceptance is illustrated in the presidential address of Mr. Alfred Nutt before the Folk-lore Society. He says: "Outside the record of history, of literature, of art, of systematized thought, the word 'race' is, for me, void of meaning. When I speak of 'race' I have in mind a community which for a definite number of centuries has manifested itself in clearly defined products of the mind—has set

upon the universal human material of speculation and fancy its special stamp and impress. Such a manifestation is by no means necessarily conditioned by blood-kinship."

It is to be regretted that such a divergence of opinion as to the proper signification of this word exists in two branches of the same science. Does it not show the necessity of an improved terminology?

THE EXTINCTION OF THE POLYNESIAN.

A HUNDRED years ago the Hawaiian Islands were said to have had 400,000 native population; now 30,000 is a high estimate. The same fearful diminution has been going on through Polynesia. Dr. Tautain has recently studied its causes in the Marquesas Islands *L'Anthropologie*, 1898, No. 4). The principal are the following: (1) Leprosy, which leads to impotence and sterility; (2) tuberculosis, which is eminently contagious and destructive; (3) syphilis, which is less marked than might be supposed; (4) licentiousness, the consequences of which are very visible in developing metritis and sterility or abortion. This last is the most injurious of all the causes, and Dr. Tautain places it as the principal factor in leading to diminished natality. The total absence of sexual morality operates in many directions to undermine the viability of the race.

D. G. BRINTON.

UNIVERSITY OF PENNSYLVANIA.

MEETING OF THE TRUSTEES OF THE MARINE BIOLOGICAL LABORATORY.

At a recent meeting of the Board of Trustees of the Marine Biological Laboratory, held at Columbia University, the report of the Treasurer showed that the funds of the institution were in a satisfactory condition. Professor S. F. Clarke, of Williams College, very generously contributed \$400 to defray the expenses of certain necessary alterations and repairs in and about the laboratory buildings, and a rising vote of thanks was given, as an expression of the gratitude of the Board for the very acceptable gift.

The following minute relative to the death of Professor Peck, the Assistant Director, was unanimously adopted:

"The Trustees of the Marine Biological Laboratory have heard with profound sorrow of the death of their colleague, Professor James I. Peck, of Williams College. They wish to record their appreciation of the invaluable service which he rendered to the Marine Biological Laboratory, and especially to express their high regard for the generous and unfailing way in which as Assistant Director he devoted himself to the maintenance and development of the Laboratory. They feel the deepest sympathy with Williams College and with his family in the loss which both have sustained."

By special vote the Board expressed itself as favorable to the establishment of more intimate relations between the Laboratory and the *Zoological Bulletin*. Circulars explaining these relations, and announcements for the forthcoming season, will be issued to members of the Corporation, and to others interested, at an early date.

The election of an Assistant Director was referred to a committee with power, and since the meeting Dr. Ulric Dahlgren, of Princeton University, for three years one of the instructors at Woods Holl in the department of invertebrate zoology, has been appointed to the position.

H. C. BUMPUS,

Secretary.

SCIENTIFIC NOTES AND NEWS.

PRESIDENT J. G. SCHURMAN and Professor Dean C. Worcester arrived at Vancouver on January 30th, and immediately embarked on the steamship 'Empress of Japan' on their way to the Philippines.

PROFESSOR D. T. MACDOUGAL, of the University of Minnesota, has been appointed to be director of the laboratories of the New York York Botanical Garden. He will enter upon the duties of the new position next July, by which time it is believed the new museum building will be ready for occupancy. The laboratory system occupies the greater portion of the upper floor, connecting with the library rooms and the herbarium.

PROFESSOR G. H. DARWIN has been elected President of the Royal Astronomical Society, London.

PROFESSOR MENDELEJEV, of St. Petersburg, has been elected a correspondent in the Section

of Chemistry of the Paris Academy of Sciences, in the room of the late Professor Kékulé. Professor Mendelejev received twenty-eight votes; Professor Fischer, of Berlin, twenty-two, and Sir William Crookes, five.

It is expected that either M. Risler, Director of the Agricultural School, or M. Roux, Sub-director of the Pasteur Institute, will be elected to the chair in the Section of Agriculture of the Paris Academy of Sciences, in the room of the late M. Aimé Girard.

We learn from *Nature* that Mr. J. G. Baker, F. R. S., has retired from the post of curator of the herbarium at Kew, in which he is succeeded by Mr. W. Botting Hemsley, F. R. S.

THE Swiney prize has been awarded for the present year to Dr. I. Dixon Mann for his book on forensic medicine and toxicology. The prize, which is awarded every fifth year by the Society of Arts and the Royal College of Physicians, is of the value of £200.

THE Geological Society, London, will this year make its awards as follows: The Wollaston Medal to Professor Charles Lapworth; the Murchison Medal to Mr. B. N. Peach, and a second Murchison Medal to Mr. John Horne; the Lyell Medal to Lieut.-General C. A. McMahon; the Bigsby Medal to Professor T. W. Edgeworth David; the Wollaston Fund to Professor J. B. Harrison; the Murchison Fund to Mr. James Bennie; the Lyell Fund is divided between Mr. Frederick Chapman and Mr. John Ward.

THE annual meeting of the New York Academy of Sciences will be held on February 27th. The President, Professor H. F. Osborn, will make the annual address, the subject being 'The Succession of Mammalian Fauna in America compared with that in Europe during the Tertiary Period.'

MR. ROBERT L. JACK, Government Geologist of Queensland, has been appointed to supervise the collection of exhibits sent by Queensland to the forthcoming Greater Britain Exhibition in London. Mr. Jack expects to reach England this month.

MR. S. A. KNAPP, a special agent of the Department of Agriculture, has arrived at San

Francisco, returning from an expedition to Asia, where he has secured seeds of agricultural products that might with advantage be cultivated in the United States.

THE St. Petersburg Academy of Medicine has elected as honorary members from Great Britain Sir William MacCormac, Sir William Turner, Lord Rayleigh, Sir William Stokes, Dr. MacEwen, Dr. Thompson and Dr. Lauder Brunton, and from Germany Professors Waldeyer, of Berlin; Streda, of Königsberg; Kühne, of Heidelberg, and Schwalba, of Strasburg.

THE death is announced at the age of 53 of Dr. Joseph Coats, since 1894 professor of pathology at the University of Glasgow. He was the author of a well-known manual of pathology and of a work on tuberculosis as well as of numerous minor contributions. The death is also announced of Sir Alfred Roberts, one of the most eminent members of the medical profession in Australia.

WE also learn with regret of the deaths of Dr. Gottlieb Gluge, emeritus professor of physiology and anatomy in the University of Brussels, at the age of 86 years, and of Dr. Constantine Vousakis, professor of physiology in the University of Athens.

News has reached Paris of the death of M. Potter, killed while making geographical explorations in Central Africa.

THE will of the late M. Louis Pierson, of Mircourt, gives 100,000 fr. to the Paris Academy of Sciences for a biennial prize to be award to the Frenchman who has made the most important discovery in physical science.

By the will of the late C. T. Mitchell, of Hillsdale, Mich., that city receives his residence and an endowment of \$10,000 for a public library.

THE Physical Society of Berlin, established in 1845, decided at its meeting of January 5th that it would hereafter be known as The German Physical Society. The object of the Society is to advance physical science by the following means: (1) The publication of proceedings especially for the prompt issue of short communications. (2) The publication of a year-book on the progress of physics. (3) Cooperation in the publication of *De Annalen*

der Physik und Chemie. (4) Participation in the meetings of the Section of Physics, of the German Society of Men of Science and Physicians. (5) Regular meetings in Berlin, and (6) A journal club.

THE Biological Laboratory of the Brooklyn Institute of Arts and Sciences, situated at Cold Spring, L. I., will open its tenth session on July 5th. The regular class work will last for six weeks, but special work may be begun earlier and continued afterwards. Dr. Charles B. Davenport, of Harvard University, is director of the laboratory, and the staff of instructors includes Dr. D. S. Johnson, of Johns Hopkins University; Professor C. P. Sigerfoos, University of Minnesota; Professor Henry S. Pratt, Haverford College; W. H. C. Pynchon, Trinity College; Nelson F. Davis, Bucknell University; Mrs. Gertrude Crotty, Davenport; Stephen R. Williams, Harvard University, and Professor Frederick O. Grover, Oberlin College.

At a meeting of the Royal Dublin Society on January 20th Sir Howard Grubb, F. R. S., Vice-President of the Society, described a plan by which the Marconi system of wireless telegraphy could be used for controlling public and other clocks.

THE Prince of Monaco reported to the Paris Academy on January 23d on the scientific results of the first expedition of his yacht, the Princess Alice II. He left Havre at the end of July and returned in the middle of September, going as far north as Spitzbergen. The fauna both of the sea and the fresh water was carefully studied. Professor Brandt, of Kiel, accompanied the expedition.

THE following lectures are being given under the auspices of Columbia University at the American Museum of Natural History, New York, on Saturday evenings: February 4th, 'The Transmission of Light in Crystals,' Professor Alfred J. Moses; February 11th, 'Characters of Minerals in Rock Sections,' Dr. Lea McL. Luquer; February 18th, 'Methods Employed in Investigation of Minerals,' Professor S. L. Penfield; February 25th, 'Testing Minerals,' Professor A. J. Moses.

THE British Treasury have approved the use of the electric light in the Natural History

Museum, South Kensington. It will be first introduced into the offices and workshops and later into the public galleries.

At a recent meeting of the Council of the Royal College of Surgeons, England, it was reported that fifteen investigators are at present carrying on original research in the laboratories of the two Royal Colleges.

OFFICIALS of the Treasury Department, customs division, have decided that books are the only articles subject to duty which can be legally imported into the United States in the mails. All other dutiable mail matter must be seized. This decision may cause some inconvenience to scientific men.

THE *Publishers' Circular* records 6,008 new books published in Great Britain in 1898, 236 less than in 1897. Under the class called vaguely arts, sciences and illustrated works, 263 books were published, a decrease of 25 as compared with the preceding year. For the United States in the year named the total number of new books published amounted to 4,886, a total smaller than that of any year since 1894. On the other hand, there was an increase over 1897 of about 1,000 books in France, the number for 1898 being 14,781. As the books published in Great Britain and the United States are mostly the same it appears that France with not half the population of the Anglo-Saxon races publishes twice as many books.

THE annual meeting of the New England Anti-vivisection Society is thus reported, in part, in the *Boston Transcript*: "Back into the room again swarmed the rest of the gentlemen, and soon another wrangle was going on in which old gentlemen in silk hats talked loudly and vigorously to one another. Threats were beginning to be made—threats of violence. Secretary Brazier finally secured a hearing: 'As custodian of all the property in this room, I ask every one present to leave,' said he, and simultaneously several women arose and started to leave the room. But Mr. Greene again had the floor. 'Don't go, ladies; he has no right to order your departure.' * * * Several personal altercations followed, one of which seemed about to culminate in violence, when the meeting broke up in confusion."

THE Jamaica correspondent of the *London Times* writes that a conference at Barbados, under the auspices of the new Imperial Department of Agriculture in the West Indies was called for January 7th and 9th. The chief chemical and botanical officers in the West Indies have been invited to take part in it. These include the officers in Jamaica, British Guinea, Trinidad and Antigua as well as Barbados. The object is to devise means for the prosecution of a policy of cooperative effort in the economic interests of the various colonies. Dr. Morris, the Commissioner of Agriculture, wisely holds that the teaching of scientific agriculture, is a subject that requires very careful consideration, and has, therefore, extended the invitation to some of the principals of high schools and colleges. The delegates from Jamaica are: Mr. W. Fawcett, B.Sc., F.L.S., Director of Public Gardens and Plantations; Mr. F. Watts, Government Analyst, and the Rev. W. Simms, M.A., Principal of University College. Among the subjects to be discussed are the cultural and chemical experiments to be undertaken to improve the saccharine contents of the sugar cane; the scientific teaching of agriculture in colleges and schools; a more skilful treatment of the soil and use of manure; and concerted action to prevent the rapid spread of fungoid and insect pests. There is no doubt that definite conclusions will be arrived at on these important points and common action determined on which may prove of the greatest possible service in developing the resources of the West Indies. Although the Imperial Department of Agriculture has been established with the specific aim of assisting the Windward and Leeward colonies and to enable experiments in cane cultivation to be carried on in continuation of former efforts in British Guiana, Barbados and Antigua, the fact that Jamaica has been invited to send representatives to the conference has been taken here as a justification for assuming that this colony may also come within the scope of its operations. It is thought that the Imperial Government should establish at least an experimental station in this island, seeing that the taxpayers already pay so much for the maintenance of a series of botanical gardens, a chemical department

and an agricultural society. Despite the existence of these organizations, practically nothing is known yet regarding the varied character and possibilities of the soil.

MR. ALBERT B. LLOYD, a young Englishman, who has just returned after traversing Stanley's great pigmy forest. He is reported by Reuter's Agency to have said: "I was 20 days walking through its gloomy shades. I saw a great many of the little pigmies, but generally speaking, they kept out of the way as much as possible. At one little place in the middle of the forest, called Holenga, I stayed at a village of a few huts occupied by so-called Arabs. There I came upon a great number of pygmies who came to see me. They told me that, unknown to myself, they had been watching me for five days, peering through the growth of the primeval forest at our caravan. They appeared to be very much frightened, and even when speaking covered their faces. I slept at this village, and in the morning I asked the chief to allow me to photograph the dwarfs. He brought ten or fifteen of them together, and I was enabled to secure a snapshot. I could not give a time exposure, as the pygmies would not stand still. Then, with great difficulty, I tried to measure them, and I found not one of them over four feet in height. All were fully developed. The women were somewhat slighter than the men, but were equally well formed. I was amazed at their sturdiness. Their arms and chest were splendidly developed, as much so as in a good specimen of an Englishman. These men have long beards halfway down the chest, which imparts to them a strange appearance. They are very timid and cannot look a stranger in the face. Their eyes are constantly shifting as in the case of monkeys. They are fairly intelligent. I had a long talk with the chief, and he conversed intelligently about the extent of the forest and the number of his tribe. I asked him several times about the Belgians, but to these questions he made no reply. Except for a tiny strip of bark cloth, men and women are quite nude. They are armed with bows and arrows—the latter tipped with deadly poison—and carry small spears. They are entirely nomadic, sheltering at night in small huts, 2ft. to

8 ft. in height. They never go outside the forest. During the whole time I was with them they were perfectly friendly."

THE *British Medical Journal* reports that all observations up to the present time tend to show that the presence of tubercle bacilli in butter is a rare event. Rabinowitsch, whose previous work on this subject was published in 1897, has lately conducted some further experiments in Berlin with the object of testing previous investigations. Fourteen butter manufactories were examined, and 15 experiments made. The produce of one factory was thus examined twice, and tubercle bacilli were found on both occasions in the butter. The remaining 18 showed no trace of true living tubercle bacilli, but in many instances pseudo-tuberculous bacilli were found. Inoculation experiments were made in all cases. During June and July the daily produce coming from the infected factory was examined. The result showed that 70 per cent. of the butter contained living tubercle bacilli. Professor Koch thought this result so remarkable that he requested Rabinowitsch to inspect another factory. In this second experiment no tubercle bacilli were found, but in some instances pseudo-tubercle bacilli had to be carefully differentiated from the true bacilli. Animals when injected with this pseudo-tuberculous material died of peritonitis. The 'isolation' of this butter factory in Berlin, which is a source of danger to the community, is certainly a triumph for the scientific method of food examination. The question whether the pseudo-tuberculous material so often present in butter is harmful to human beings will be a matter for future investigation.

UNIVERSITY AND EDUCATIONAL NEWS.

THE sum of \$50,000 is given to the Massachusetts Institute of Technology by the will of the late Edward B. Hosmer, of Boston.

By the will of Mr. David Acheson £10,000 is left to the University of Melbourne for the foundation of scholarships.

THE convocation of the University of the State of New York will be held on June 26th to 28th. President Harper, of the University of Chicago, will deliver the annual address, his

subject being 'Waste in Education.' Superintendent Horace S. Tarbell will present a paper on the schools of that city, describing their methods of dealing with especially bright and especially backward students.

HARVARD UNIVERSITY will spend \$175,000 in the erection of a new building for the department of engineering of the Lawrence Scientific School. The building will be situated on Holmes Field.

THE number of students matriculated at the University of Edinburgh during the past year was 2,813, of whom 211 are women. The enrollment in the different Faculties is as follows: Arts, 817; science, 147; divinity, 63; law, 373; medicine, 1,387; music, 26.

AT a recent meeting of convocation of the University of London the following resolution was carried: That the value of the B.A. degree has been distinctly lowered by the recent changes in the final examination, which enable a candidate to obtain the degree without taking any of those subjects (*e. g.*, mathematics and mental and moral science) which involve a discipline in the more abstract kind of thought.

HARVARD UNIVERSITY some time since established a class somewhat similar to the docents of the German University, though the lectureships are limited to a period not exceeding four months, and the University does not even collect such fees as may be charged. The first lectures under this system are now announced. They are a course on the geology and geography of the oceans by Dr. R. A. Daly and a course on history of the philosophical tendencies of the 19th century by Dr. W. P. Montague.

THE resignation of Dr. D. T. MacDougal, to accept a position in the New York Botanical Garden, leaves a vacancy in the assistant professorship of botany at the University of Minnesota. It will probably be filled at the April meeting of the Board of Regents.

DR. J. TAFEL has been promoted to an assistant professorship of chemistry in the University at Würzburg, and Dr. E. O. Schmidt, of Leipzig, has been made professor of chemistry in the medical school at Cairo. Dr. Otto Nässe, professor of pharmacology in the University at Rostock, has retired.

SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; J. LE CONTE, Geology; W. M. DAVIS, Physiography; O. C. MARSH, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; HENRY F. OSBORN, General Biology; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; J. McKEEN CATTELL, Psychology; DANIEL G. BRINTON, J. W. POWELL, Anthropology.

FRIDAY, FEBRUARY 17, 1899.

THE ECONOMIC STATUS OF INSECTS AS A CLASS.*

CONTENTS:

<i>The Economic Status of Insects as a Class</i> : L. O. HOWARD	233
<i>Anti-friction Alloys</i> : R. H. T.....	247
<i>Annual Meeting of the American Psychological Association</i> : DR. LIVINGSTON FARRAND.....	249
<i>Scientific Books</i> :—	
<i>The New Maryland Geological Survey</i> : BAILEY WILLIS. <i>La vie sur les hauts plateaux</i> : PROFESSOR GEORGE BRUCE HALSTED. <i>Books Received</i>	252
<i>Scientific Journals and Articles</i>	257
<i>Societies and Academies</i> :—	
<i>The Biological Society of Washington</i> : DR. O. F. COOK. <i>The New York Section of the American Chemical Society</i> : DR. DURAND WOODMAN.....	257
<i>Discussion and Correspondence</i> :—	
<i>Reply to Critics</i> : MAJOR J. W. POWELL. <i>Artificial Dreams</i> : DR. HIRAM M. STANLEY. <i>Trowbridge's Theory of the Earth's Magnetism</i> : PROFESSOR L. A. BAUER, PROFESSOR JOHN TROWBRIDGE.....	259
<i>Notes on Inorganic Chemistry</i> : J. L. H.....	266
<i>Zoological Notes</i>	266
<i>Current Notes on Anthropology</i> :—	
<i>Ethnography of Liberia</i> ; <i>The Significance of Skull-masks</i> ; <i>The Scastica in America</i> : PROFESSOR D. G. BRINTON.....	267
<i>Scientific Notes and News</i>	267
<i>University and Educational News</i>	271

THE popular conception of insects in general is undoubtedly that they are injurious. Many writers, it is true, have pointed out the benefits derived from insects, but we think of their damage to crops and of their annoyance to man and animals, and this aspect of the subject is at once apt to preponderate in our minds. It is more than 80 years since Kirby and Spence contrasted the injuries caused by insects with the benefits derived from them, and it has not been comprehensively done since. In the meantime, whole groups of important injuries have been developed and whole classes of beneficial work have been discovered. Moreover, the tendency of modern thought has not taken this direction. The biologic, taxonomic and phylogenetic, and other aspects of large groups of forms of life have been considered to the exclusion of the economic aspect, and even where this side has attracted attention investigators have confined themselves to specific problems and have not generalized. It may be interesting, therefore, once more to contrast the injurious insects with the beneficial ones in an effort to gain a clearer idea of the status of the group in its relations with man.

In a broad way, we may consider the subject under the following heads:

* MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor. Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

* Address of the retiring President of the Biological Society of Washington, delivered January 18, 1899.

Insects are injurious :

1. As destroyers of crops and other valuable plant life.
2. As destroyers of stored foods, dwellings, clothes, books, etc.
3. As injuring live stock and other useful animals.
4. As annoying man.
5. As carriers of disease.

Insects are beneficial :

1. As destroyers of injurious insects.
2. As destroyers of noxious plants.
3. As pollenizers of plants.
4. As scavengers.
5. As makers of soil.
6. As food (both for man and for poultry, song birds and food fishes) and as clothing, and as used in the arts.

DESTROYERS OF CROPS AND OTHER USEFUL PLANTS.

In the present balance of nature one of the chief functions of insect life is to keep down superabundant vegetation. Almost every kind of plant has its insect enemies, and has had such enemies for many thousands of years. So soon as man began to make an effort to upset nature's balance by cultivating certain plants at the expense of others he encountered nature's opposition by means of the increase of insect enemies of the particular plant cultivated, and almost as early as there is any record of agriculture in literature there is also mention of the destruction to crops caused by insects. Witness the writings of the prophet Joel, who might almost be termed an agricultural pessimist.

At the present time almost every cultivated crop has not only its thousands upon thousands of individual insect enemies, but it is affected by scores and even hundreds of species. A mere tabulation of the insect enemies of the apple already recognized in this country shows 281 species, of clover 82 species, and of so new a crop as the sugar

beet 70 species. The insects of the vine, of the orange, of the wheat crop, and, in fact, of all of our prominent staples, show equally startling figures.

The actual damage which is done by insects in this way is difficult to express. Many attempts have been made by writers on economic entomology to express it in money values. For example, it was estimated by the late Professor Riley that the average annual damage to cultivated crops by injurious insects in the United States amounted to three hundred millions of dollars. The loss from the ravages of one species alone, the chinch bug, during one year was estimated at sixty millions of dollars. While it is true that the combined losses of individual growers might reach such enormous sums as these, there is an element in the total loss which we must not fail to take into consideration, and that is the enhanced value of the portion of the crop which remains. Even in the case of an individual a man may lose, for example, half of his crop through the work of the chinch bug, and yet, through widespread damage by this insect, the money value of the portion harvested may reach an amount almost as great as would have been gained through the low prices of a successful year of no insect damage. As this applies to an individual, it applies much more strongly to a State or to the country at large, so that even in the year when the grain crop of the country was said to have been damaged to the extent of sixty millions of dollars it is safe to say that the total price gained for the crop was as great as it would otherwise have been. These estimates of damage, therefore, would much better be expressed in terms of bushels, or some other measure, than in money value.

It is this aspect of our subject, the damage done by injurious insects to agriculture, that has given rise to the comparatively new branch of applied science which we

now know as economic entomology, and which, although originating in Europe, has been encouraged to such an extent in our own country, owing partly to our greater necessities and partly to our practical turn of mind, that it is safe to say that at present America leads the rest of the world in this direction.

It is undoubtedly true that this enormous injury to crops is the chief item in a general consideration of the injuries brought about by insects.

AS DESTROYERS OF STORED FOODS, DWELLINGS,
CLOTHES, BOOKS, ETC.

It is safe to say that there is hardly any product of man's ingenuity, hardly one of the thousands of useful materials upon which depend his comfort and happiness, which is not damaged, directly or indirectly, by insects. The timbers of which his dwellings are built, nearly all of his household utensils, his garments, practically everything which he uses as food, many of the liquids used as drink, his books, the ornaments with which he surrounds himself, the medicines which he takes when sick, the very tobacco with which he solaces himself—all are destroyed or injuriously affected by insects. There is, perhaps, one group of exceptions, and that is those articles which are composed wholly of metal, and yet even here insects may occasionally play an injurious part, since instances are on record of the destruction of lead pipes by insect larvæ, and the perforation of the metal linings of water tanks by small beetles.

Such injuries to human products are more frequent and serious in tropical regions than in temperate zones, but even here insects of this nature cause very serious inconvenience and great annual loss. It will answer our purpose, perhaps, to list some of the varying substances which are damaged in this way, to get an idea of their almost uni-

versal character: Ham, cheese, salted fish, butter, lard, dried mushrooms, rye bread, sweetmeats and preserves, powdered coffee, almonds and other nuts, raisins, breakfast foods, chocolate, ginger, rhubarb, black pepper, vinegar, sugar, wines, canned soups, tobacco, snuff, licorice, peppermint, aromatic cardamon, aniseed, aconite, belladonna, musk, opium, ginseng, chamomile, boneset, hides, shoes, gloves and other leather articles, furniture, carpets, drawings and paintings, paint brushes, gun wads, combs, etc., made of horn; hay, oats, straw, willow baskets, ax handles, ladders, wheel spokes and all sorts of agricultural implements with wooden handles, barrels, wine casks, corks of wine bottles, sheets of cork, natural history collections, including skeletons and mummies, and even Persian insect powder! The mention of this well-known insecticide reminds one of the latest discovery, which is that certain flies in California breed in the crude petroleum pools in the vicinity of oil wells, a fact which is almost paradoxical in view of the extensive use of petroleum as an insecticide.

AS INJURIOUS TO LIVE STOCK AND OTHER
USEFUL ANIMALS.

Every species of animal which has become domesticated and is of value to man possesses its insect parasites and enemies. These in many cases are the same species which affect man and which we will mention in the next section; others are specific to the animals or groups of animals which they affect. Horses, cattle, sheep, all possess insect enemies which are not only very deleterious to their health, but frequently cause their death in numbers.

The disgusting bot fly of the horse, whose maggots live in incredible numbers in the stomach and intestines of this noble friend of the human race; the bot fly of the ox, which causes innumerable sores on the backs of cattle and by its perforations ruins

their hides for commercial use; the bot fly of the sheep, which inhabits the nasal and orbital sinuses of the sheep and produces insanity and death—will instantly be recalled by those who are familiar with stock raising, while hundreds of other species, some in no less degree, as the horn fly, the numerous gad flies, including the Tsetse fly of Africa, the screw worm fly of our South-western country, unite to make the lives of domestic animals a burden to themselves and a trial and a loss to their owners.

An interesting attempt was made some years ago by a prominent Western agricultural newspaper, *The Farmers' Review*, to estimate approximately the pecuniary loss from the attacks of a single one of these insects—the ox bot fly, or ox warble—on the cattle received at the Union Stock Yards, of Chicago. It was estimated that 50 per cent. of the cattle received each year are affected. The number of cattle received at the yards during six months of the year 1889 was 1,335,026; the average value of the hide was \$3.90; the usual deduction for hides damaged by the ox warble was one-third. Estimating at less than one-third, say \$1.00, the actual loss during six months on hides alone was \$667,513. When to this was added the loss for depreciation in value and lessened quantity of beef, the loss for each infested animal was put at \$5.00, a very low estimate, indicating the total loss from the animals in the Union Stock Yards, of Chicago, for a period of six months of \$3,336,565.

AS ANNOYING MAN.

There are very few regions of the habitable globe where man is not personally subject to more or less annoyance by insects. In this part of the world we naturally think at once of mosquitoes, house flies, fleas, and of a certain other species which it will not be necessary to name.

A susceptible individual some years ago

wrote to the Department of Agriculture and said that he had come over from the old country and settled in New Jersey, but that the mosquitoes bothered him so greatly that on the advice of friends he moved to northern New York. Here he found that during a certain portion of the year black flies made life unendurable; thereupon he packed his household effects and moved to North Carolina. Here, however, in the summer months red bugs, or jiggers, bothered him to such an extent that he feared he would go crazy, and in this desperate condition he applied to this office to learn whether there existed in the United States a locality where a sensitive individual could find peace from attacks of insects. He said that he had been told that in the Western country the buffalo gnat was greatly to be feared, while certain other biting flies would be sure to keep him in a constant state of dermal irritation; that further south he knew that peaceful nights were to be gained in the summer time only under the protection of mosquito bars. He had thought of the newly developing country of Alaska, but had recently seen an account in the newspaper of the ferocity of the Alaskan mosquitoes, which had practically destroyed his last hope.

Accustomed as most of us are to the mosquitoes of temperate North America, we hardly realize the impression which they made upon the early English travellers. A story told by Kirby and Spence, to the effect that Mr. Weld in his travels relates from General Washington that in one place the mosquitoes were so powerful as to pierce through his boots, has always excited my interest and curiosity, and I recently took the trouble to consult the original publication, which is 'Isaac Weld's Travels through North America, 1795-1797,' London, 1799. In speaking of Skenesborough, in northern New York, Mr. Weld dilates upon the number and ferocity of the mosquitoes, and

makes use of the following words: "General Washington *told me* that he never was so much annoyed by mosquitoes in any part of America as in Skenesborough, for that they used to bite through the thickest boot." Now, knowing that the boots of those days were very thick and that the mosquitoes of that time must have been structurally identical with those of to-day, there arises instantly a question of veracity between Mr. Weld and General Washington; and as we know from Dr. Weems' veracious history that General Washington was so constituted that he could not tell a lie, it looks very much as though Mr. Weld, like many another English traveller who has written a book on his return home, has been inclined to overstate the truth.

In these days of comparative personal cleanliness some of the most disgusting of the insect annoyers of man have dropped out of sight. The lice, which in former days were common in all classes of society, from king to peasant, are now comparatively unknown. The itch disease, which carried off many a famous character in history, is equally rare. That it still persists, however, is shown by an occasional case reported in medical journals. For example, Dr. Robert Hessler, of Indianapolis, reported in 1892 a case in his own practice of typical Norway itch in which the itch mites were present in the skin of the patient in enormous numbers. A rough estimate showed seven million eggs and two million mites.

Those of us who live in a reasonably civilized way are confined, in our experience of annoying insects, largely to the forms mentioned in our opening paragraph, namely, mosquitoes and house flies and rarely fleas; but a glance through the medical literature reveals the existence of more or less frequent cases of such a nature that they are little less than horrible. Prominent among these are the cases of so-called Myasis, and

especially those resulting from the attacks of the screw worm fly, *Comptosmyia macellaria*.

Residents of temperate regions are fortunate as compared with those of tropical regions in respect to the personally annoying insects. Our troubles from these individually insignificant causes are intensified to a degree in warmer countries, where the comfort of the individual absolutely depends upon the adoption of measures, always difficult and frequently impracticable, to exclude insects from his person and from his food. This is so well known in these days of numerous books of travel that I will close this aspect of our question simply with a quotation from a poet of the Indies, written many years ago:

"On every dish the booming beetle falls,
The cockroach plays, or caterpillar crawls:
A thousand shapes of variegated hues
Parade the table and inspect the stews:
To living walls the swarming hundreds stick,
Or court, a dainty meal, the oily wick;
Heaps over heaps their slimy bodies drench,
Out go the lamps with suffocating stench.
When hideous insects every plate defile,
The laugh how empty, and how forced the smile!"

AS CARRIERS OF DISEASE.

Manson's demonstrated transmission of the filaria diseases of the East (elephantiasis, chyluria and lymph scrotum) by insects; the discovery by Salmon and Smith of the carriage of the germ of Texas fever by the well-known Southern cattle tick; the discovery by Koch of the fact that the Tsetse fly of Africa is so destructive to animals, not by its bite alone, but by carrying into the circulation of the animal that it attacks the micro-organisms of disease; the demonstration by Howe and others of the previously suspected fact that the purulent conjunctivitis of the Egyptians is spread by the house fly; the partly proven hypothesis of Manson and Grassi of the relation existing between mosquitoes and malaria; the circumstantially proven carriage of the

germs of Asiatic cholera and typhoid fever by flies; the demonstration claimed by Finlay of the carriage of a mild type of yellow fever by mosquitoes; the suggestion by Hubbard that the 'pink eye' of the South is spread by Hippelates; the well-recognized fact among the Europeans of the Fiji Islands that without a veil a serious native eye disease will spread through the medium of gnats; the suggestion by Symond of the agency of fleas in the spread of the bubonic plague; the demonstration of anthrax bacilli in malignant pustules in human beings, caused by the bite of *Tabanus* and *Stomoxys*—all indicate an important and very injurious function of insects practically unsuspected until comparatively recent years. It is, in fact, a rapidly increasing field of investigations, the possibilities of which cannot be accurately established at the present time. It is, however, not a field which should be left entirely to the medical bacteriologist; the entomologist should have a share. The life histories and habits of the insects concerned in the damage should be thoroughly understood, since it is not impossible that otherwise the medical investigators may find themselves arriving at perhaps unwarranted conclusions. For example, it is a fact probably unknown to the medical men who may be strongly impressed by the suggested carriage of typhoid germs by flies, that the house fly, so common in our dining rooms, does not breed in and rarely visits human excrement, while those other kinds of flies, which do so breed, are rarely attracted to articles of food used by human beings. In the crowded and unnatural conditions of army camps, however, and especially where cavalry regiments are stationed, so that there are great amounts of horse manure, the house fly may breed in such enormous numbers as to render of very likely occurrence a departure from the normal food habits of the adult.

Enough has been shown, however, to emphasize the potentiality of this phase of insect injury.

BENEFITS

AS DESTROYERS OF INJURIOUS INSECTS.

The economic bearings of insect enemies of insects are very great, and perhaps this is, all things considered, the most important of the beneficial function of insects as a class.

In the eternal warfare of organism upon organism, in the perpetual strife of species, one preying upon another and that upon a third, the complications of relations of forms which determine the abundance of one species and the scarcity of another are nowhere more marked than among the insects. In fact, to the student of insects who has followed out even a single chain of these inter-relationships the thought must necessarily come that upon its organic environment, and especially upon its relations with its living neighbors of the animal kingdom, depend the chances of a species not only for increase, but for survival almost to no lesser degree than upon its inorganic environment. Temperature is the great factor which controls the geographical distribution of life, and temperature is at the back of all these apparent living first causes which control the abundance of a species in a given region, provided we trace them far enough. Yet these living causes, themselves affected by other living causes in an almost endless chain, sometimes, to all appearance, dwarf even temperature as a controlling factor.

There is not a species of insect that has not its natural enemies in the guise of other insects; there is not one of these other insects which has not its own insect foes. From a single species of Bombycid moth, the larvæ of which frequently damage forests in Europe to an alarming extent, there have been reared no less than sixty species of hymenopterous parasites. From a

single caterpillar of *Plusia brassicae* have been reared 2,528 individuals of a little hymenopterous parasite, *Copidosoma truncatellum*.*

Outbreaks of injurious insects are frequently stopped as though by magic by the work of insect enemies of the species. Hubbard found, in 1880, that a minute parasite, *Trichogramma pretiosa*, alone and unaided, almost annihilated the fifth brood of the cotton worm in Florida, fully ninety per cent. of the eggs of this prolific crop enemy being infested by the parasite. Not longer ago than 1895, in the city of Washington, more than ninety-seven per cent. of the caterpillars of one of our most important shade-tree pests were destroyed by parasitic insects, to the complete relief of the city the following year. The Hessian fly, that destructive enemy to wheat crops in the United States, is practically unconsidered by the wheat growers of certain States, for the reason that whenever its numbers begin to be injuriously great its parasites increase to such a degree as to prevent appreciable damage.

The control of a plant-feeding insect by its insect enemies is an extremely complicated matter, since, as we have already hinted, the parasites of the parasites play an important part. The undue multiplication of a vegetable feeder is followed by the undue multiplication of parasites, and their increase is followed by the increase of hyperparasites. Following the very instance of the multiplication of the shade-tree caterpillar just mentioned, the writer was able to determine this parasitic chain during the next season down to quaternary parasitism. Beyond this point, true internal parasitism probably did not exist, but even

these quaternary parasites were subject to bacterial or fungus disease and to the attacks of predatory insects.

The prime cause of the abundance or scarcity of a leaf-feeding species is, therefore, obscure, since it is hindered by an abundance of primary parasites, favored by an abundance of secondary parasites (since these will destroy the primary parasites), hindered again by an abundance of tertiary parasites, and favored again by an abundance of quaternary parasites.

The subject of practical handling of insect enemies of insects has come into great prominence during the past ten years. The suggestion by the Rev. Dr. Bethune, of Canada, many years ago, of the desirability of importing the European parasite of the wheat midge into America was probably the first published international suggestion of this nature, and, although some subsequent correspondence between English and American entomologists ensued, no parasites were actually sent over. Later, attempts were made by LeBaron in the case of a parasite of the oyster-shell bark-louse of the apple, and by Professor Riley in the case of a parasite of the plum curculio, to transport parasites from one section of the United States to another, both attempts meeting with some slight success.

In 1873 Planchon and Riley introduced an American predatory mite, which feeds in this country on the grape vine *Phylloxera*, into France, where it became established, but where it accomplished no appreciable results in the way of checking the spread of this famous vine pest.

In 1874 efforts were made to send certain parasites of plant-lice from England to New Zealand, without recorded results of value.

In 1880, in an article upon the parasites of American scale insects, the writer showed that international transportation is especially easy, and especially desirable in the case of these insects.

* This observation, which for some years 'held the record,' as the expression is, was made by Mr. Pergande, of the U. S. Department of Agriculture. Recently, however, Professor A. Giard, of Paris, has more than 3,000 specimens of the same parasite reared from a *Plusia* caterpillar.

In 1883 Dr. Riley succeeded in importing a common European parasite of the imported cabbage worm into this country, where it established itself and has since proved to be a valuable addition to our fauna.

In 1891 the same distinguished entomologist brought about the importation of one of the European parasites of the Hessian fly through the assistance of Mr. Fred. Enock, of London. This parasite maintained itself in this country certainly as late as 1895, but has accomplished no appreciable good, so far as has been ascertained, in limiting the increase of this destructive enemy to wheat.

All previous experiments of this nature were dwarfed into insignificance by the astounding success of the importation of *Novius* (*Vedalia*) *cardinalis*, a ladybird beetle, from Australia into California in 1889. This importation was made, as will be remembered, by Mr. Albert Koebele, an attaché of the Division of Entomology of the United States Department of Agriculture, whose expenses, however, were paid out of a fund appropriated to the Department of State, for the purpose of securing a representation from this country at the Melbourne Exposition. A California man, the late Mr. Frank McCoppin, happened to be at the head of the Exposition Commission; and, while the late Dr. C. V. Riley was endeavoring in Washington to induce the Department of State to set aside a sum, from the Exposition fund, for the expenses of Mr. Koebele, representatives of the State Board of Horticulture of California were pressing the same facts upon Mr. McCoppin, the head of the Commission. These efforts were being made independently and without consultation, hence it happened that after Mr. Koebele had succeeded in sending live *Vedalias* to California, and after these insects, by their rapid multiplication and voracious habits, had absolutely destroyed the cottony cushion scale in the orange

groves of the State, a result which practically saved millions of dollars to California, and which attracted the attention of everyone interested in science or agriculture, a most unfortunate controversy ensued between Dr. Riley and the California State Board of Horticulture as to the placing of the credit of carrying out this wonderfully successful experiment. This controversy embittered the last days of both Dr. Riley and Mr. McCoppin, and was the cause of a disturbance of the formerly pleasant relations between the United States Department of Agriculture and the State Board of Horticulture of California, which has only recently been overcome.

Following this successful experiment, the same insect, *Novius cardinalis*, was sent to South Africa, where it exterminated the white or fluted scale in that colony. The next year it was sent to Egypt, where it exterminated a congeneric scale insect in the gardens of Alexandria.

The following year Mr. Koebele, still an agent of the United States Department of Agriculture, was sent with the consent of the Honorable Jeremiah Rusk, but at the expense of the California State Board of Horticulture, to Australia, New Zealand and the Fiji Islands, for the purpose of securing other valuable beneficial insects for importation into California. Thousands of such insects, comprising a number of different species, nearly all, however, of them Coccinellids, or ladybirds, were sent over and established in California. Several of these species are still living in different parts of the State. The overwhelming success of the importation of *Novius cardinalis* was not repeated, but one of the insects brought over at that time, namely, *Rhizobius ventralis*, has unquestionably ridden many olive groves of the destructive black scale, and is to-day present in many other orchards in such numbers that the scale practically makes no headway.

After this second Oriental trip the relations between the Department of Agriculture and the State Board of Horticulture of California became so strained that the California agents of the Department were given their choice by the Honorable Secretary of Agriculture to resign their positions or be transferred to Washington. Mr. Koebele resigned and was soon after employed by the then newly established Hawaiian Republic for the purpose of travelling in different countries and collecting beneficial insects to be introduced into Hawaii for the purpose of destroying injurious insects. It is difficult at this time to ascertain the exact results of the more recent portion of this work. Mr. Koebele's own published reports have dealt less with results than with the details of the introduction of insects, and anonymous newspaper reports are not to be accepted as scientific evidence. Fortunately, however, one of the collectors of the British Association for the Advancement of Science, Mr. R. E. C. Perkins, was in Hawaii during 1896 and made a report on Mr. Koebele's work to the committee appointed by the Royal Society and the British Association for investigating the fauna of the Sandwich Islands, which was published in *Nature* for March 25, 1897. From this report it appears that the introduction of *Coccinella repanda* from Ceylon, Australia and China was so successful in the extermination of plant-lice upon sugar cane and other crops as to obviate all necessity for spraying. The introduction of *Cryptolemus montrouzieri* from Australia resulted in the entire recovery of the coffee plants and other trees which were on the point of being totally destroyed by the scale insect known as *Pulvinaria psidii*. Eight other introduced species had at the date of writing (November, 1896) been entirely naturalized and were reported as doing good work against certain scale insects. A Chalcid fly, *Chalcis obscurata*, introduced from

China and Japan, multiplied enormously at the expense of an injurious caterpillar which had severely attacked banana and palm trees. Mr. Koebele, when visiting Washington during November, 1898, mentioned a number of other importations of beneficial insects into Hawaii, about which it is as yet too early to speak.

A very recent instance of an international importation of striking value is the sending of *Novius cardinalis* from this country to Portugal, where the white or fluted scale has been checked and in many orchards exterminated in the course of a single year. This importation was made by the writer with the invaluable assistance of the California State Board of Horticulture.

Other experiments in this line are under way. A parasite of certain wax scales, which are abundant and injurious in the South, has been imported by the writer from Italy, with the cooperation of Professor Antonio Berlese, of the Royal Scuola di Agricoltura di Portici; while an effort is being made to bring from Europe insects which will prey upon the Gipsy moth which has been so great a plague about Boston; and other parasites of injurious scale insects in foreign countries are being studied with the purpose of eventually obtaining their introduction into the United States.

AS DESTROYERS OF NOXIOUS PLANTS.

Just as we have shown how important is the rôle played by insects in the destruction of cultivated and useful plants, it will be easy to indicate their importance as destroyers of weeds and other noxious plants. We need only mention the common and cosmopolitan thistle butterfly (*Pyrameis cardui*), the equally common milkweed butterfly (*Anosia plexippus*), the purslane caterpillar (*Copidryas gloveri*), the burdock beetle (*Gastroidea cyanea*), and the purslane sphinx moth (*Deilephila lineata*) to recall to the mind of the experienced entomologist many

other species which do similar work. They are here, as in the former case, perhaps the principal agents in preventing the undue increase of any one species of plant, but as we find here not an effort of man to combat Nature, as it were, by increasing the growth and spread of one species at the expense of the others, but the exact opposite, so, here also, to a degree we find Nature arrayed against man, and insects thus play by no means the same part in the destruction of weeds that they do in the destruction of cultivated crops. Nevertheless, they have an important function in this direction, and it is safe to say that the benefit which the agriculturist derives from their work in this way is very great. As long ago as the beginning of the century it was pointed out by Sparrman that a region in Africa, which had been choked up by shrubs, perennial plants and hard, half-withered and unpalatable grasses, after being made bare by a visitation of destructive grasshoppers, soon appeared in a far more beautiful dress, clothed with new herbs, superb lilies and fresh annual grasses, affording delicious herbage for the wild cattle and game.

In a similar way Riley has called attention to the fact that after the great grasshopper invasions of Colorado and other Western States in the years 1874 to 1876 there were wonderful changes in the character of the vegetation, the grasshopper devastations being followed by a great prevalence of plants which in ordinary seasons were scarcely noticed. It is true that some of these plants were dangerous weeds, but others were most valuable as forage for the half-starved live stock. Moreover, other plants, and especially short or recumbent grasses, took on a new habit and grew luxuriantly; one species, for example, *Eragrostis poaeoides*, ordinarily recumbent and scarcely noted, grew in profusion to a height of three and a-half feet.

An important, but not generally realized,

benefit which is derived from the insects may be mentioned under this head, though not strictly belonging here. Kirby showed, 75 years ago, that the insects that attacked the roots of grasses, such as wireworms, white grubs, etc., in ordinary seasons only devour so much as is necessary to make room for fresh shoots and the product of new herbage, in this manner maintaining a constant succession of young plants and causing an annual though partial renovation of our meadows and pastures, "so that, when in moderate numbers, these insects do no more harm to the grass than would the sharp-toothed harrows which it has sometimes been obliged to apply to hide-bound pastures, and the beneficial operation of which in loosening the subsoil these insect borers closely imitate."

AS POLLENIZERS OF PLANTS.

It can no longer be doubted that cross fertilization is one of the very most important elements in the progressive development and continued health of the great majority of flowering plants, and, indeed, that it is with some almost a condition of existence. Opposition to this view, at no time especially strong since the publication of Darwin's great work, has become feebler and more feeble until at the present it is not worth considering.

Comparative experimentation with self-fertilizing and cross-fertilizing plants, repeated with many species and genera, have shown a superior growth and vitality on the part of those subjected to cross-fertilization of such a degree as to leave not a semblance of a doubt; while in individual cases self-fertilization has been scientifically shown to even result in a deterioration so marked that it has been compared to poisoning.

In this condition of affairs it at once becomes evident that the good offices of insects in this direction are of incalculable

importance, since it must be plain that of the natural agencies by which cross-fertilization of plants is accomplished insects are far and away the most prominent. Every investigation which has been undertaken of recent years, and activity in this field is increasing by leaps and bounds, has shown the most marvelous adaptations between the structure of flowers and the structure of their insect visitants, all in the line of facilitating or really enforcing the collecting and carriage of pollen by flower-visiting insects from one plant to another. An estimate of the numbers of the species of insects engaged in this work would include the forms belonging to whole families and almost orders, and if we could imagine the race of flower-visiting insects wiped out of existence the disastrous effect upon plant growth would be beyond estimate. I am not prepared to state that insects benefit plants in this way to such an extent as to overcome the results of the work of the plant-destroying species, but if it were possible to compare in any way the results of these two classes of work it is safe to say that the effect would be surprising.

We must, therefore, without going further into detail, place this pollenization of plants as one of the very most important beneficial functions of insects in their relations to man.

AS SCAVENGERS.

Another beneficial function of insects, the importance of which can hardly be overestimated, is their value to humanity in doing away with, and rendering innocuous, dead matter of both plant and animal origin. This subject has never been discussed without reference to the famous statement by Linnaeus that the offspring of three blow-flies would destroy the carcass of a horse as quickly as would a lion; and while the exact statement in its details is open to doubt, still it serves to illustrate, in a striking way, the good offices of insects, and it is

certainly true that after the offspring of the blow-fly have finished with the horse's carcass this would be left in a much less offensive condition than after the departure of the lion.

There are inhabited regions in which the climate is so dry that dead bodies of animals never become offensive, but, by natural mummification, remain simply as cumberers of the earth. In such regions insects play little part. Wherever, however, there is sufficient moisture to produce a natural decay, there insects occur in swarms and hasten the destruction of the decomposing mass in a marked degree. Were the bodies of dead animals not destroyed by insects in this way, and, still more, were the destruction of dead vegetation not hastened as it is by the attacks of countless insects, it is perfectly easy to see that the earth would not be inhabitable, its surface would be covered with the indestructible remains of what was once life in some form.

Large groups of insects, comprising many thousands of species, take part in this inestimable work, and it will probably be unnecessary in order to bring about a realization of this value to dwell further upon the subject.

AS MAKERS OF SOIL.

It is a fact not generally realized that insects must take an important part in the changes in the character of the soil which are constantly going on. Occurring in such countless millions, as they do, constantly penetrating the soil in all directions, frequently dragging vegetation below the surface and bringing the subsoil up to the surface, changing the character of the soil humus by passing it through their bodies, and fertilizing the earth by their own death and decay, it is probable that insects are responsible for even more soil change than are the earth worms, which Darwin has placed before us in such an important light.

Insects are found beneath the ground in

incredible numbers; some of them pass their whole life underground, feeding upon roots and rootlets, upon dead and decaying vegetable matter, upon soil humus and upon other insects; many of them have their nests underground, although they get their food elsewhere; while others hide their eggs or pupæ underground.

The depth to which they penetrate is something surprising; the minute insects of the family Poduridæ have been found swarming literally by the million at a depth of six to eight feet in a stiff clay subsoil.

AS FOOD AND CLOTHING AND AS USED IN THE ARTS.

In this rôle insects play an important part. Insects as food, and their products as clothing, are well known to all. The great silk industry of the world is derived wholly from insects, and almost entirely from a single species, the silkworm of commerce.

As food, insects have formed articles of diet for certain savage peoples since the beginning of the human race. Hope, in 1842, catalogued forty-six species of insects used as food, and Wallace, in 1854, showed that insects of six different Orders were used as food by the Indians of the Amazon. Semi-civilized peoples to-day use certain insects as food, as witness the consumption of *Corixa* eggs by the Mexicans, and a book has been written under the caption 'Why not eat insects?' for the purpose of showing that many possibilities in the way of dietetics are being ignored to-day. M. de Fontvielle, in addressing the Société d'Insectologie, in 1883, expressed regret that the attempts made to popularize the use of insects as food have made so little progress, and said that we ought not to forget the remark of the Roman Emperor who said that the body of an enemy never tasted bad, and that the banquet of the Society would always lack something so long as

there was not placed before them at least some grasshopper farina and fried white worms.

A single insect, the honey bee, furnishes a notable article of food, and is the basis of a great and world-wide industry.

As food for poultry, song birds and food fish, insects are indirectly of great benefit to man. Not only do they provide living food for such animals, but *Corixa mercenaria*, a water bug, is now being imported by the ton from Mexico into England as food for birds, poultry, game and fish. One ton of these bugs has been computed by Mr. G. W. Kirkaldy to contain 250,000,000 of insects (*Entomologists' Monthly Magazine*, August, 1898).

In the days of pure empiricism in medicine, insects were used extensively, and we have only to mention the Spanish fly to show that they are still of some value.

In the arts, shellac and Chinese white wax, as is well known, are insect products, as also are the formerly greatly used cochineal dye and Polish berry dye, the so-called berry in this case being an insect and not a berry.

The last-named instances are all derived from scale insects, a group of astonishing capacity for multiplication, the commercial possibilities of which are by no means exhausted, as I took pleasure in showing in a paper read before the American Association for the Advancement of Science in 1897. It should be noted here, also, that there is good reason to believe that the manna of the Bible, upon which the Children of Israel subsisted while in the Wilderness, was also the secretion of a scale insect.

SUMMARY OF THE HABITS OF INSECTS.

After this general account, arranged under the classes of damage and classes of benefits brought about by insects, it will be well to attempt an arrangement of the subject in a somewhat different manner, in order to gain,

if possible, some light as to the relative proportion of insects which are injurious or beneficial.

It will be manifestly impossible to catalogue the species or the genera in this way, and it will be obvious that a classification from families will be lacking in exactness, since some of the families are very large in number of species and others exceedingly small; but, taking the groups as a whole, no better and speedier means suggests itself than to summarize the habits by families.

Another difficulty, however, which arises in such a classification is the fact that some orders are in a much more advanced stage of classification than others, and the force which is given to a family as a taxonomic group varies with the views of the latest monographer. Nevertheless, taking only the older and generally accepted families and analyzing habits, we find the situation to be as follows:

Of 33 families of Hymenoptera, but two are strictly plant-feeding; the Cynipidæ, or gall flies, are in the main injurious to plants, but some forms are parasitic; nine families are strictly parasitic upon other insects; fifteen are predatory upon other insects; two, comprising the bees, have no other especial value in their relations with man than as pollenizers of plants, or producers of honey; three, comprising the ants, are beneficial as scavengers, but injurious in their other relations. It must be remembered, however, that at least 27 of the 33 families are of the greatest value in the cross-fertilization of plants, in which work the insects of this order perhaps take the lead.

In the Coleoptera, or beetles, considering 82 families, the insects of nine families on the whole are injurious, and of 23 families on the whole are beneficial as destroying injurious insects; 10 families are beneficial as scavengers, and 30, or more, mostly small groups of little importance, contain some

scavengers and many neutral forms of practically no economic importance, although certain of them visit flowers; two families contain both injurious and beneficial forms, as well as many that are neutral.

In the Siphonaptera, or fleas, the species of the single family are parasitic upon warm-blooded animals.

In the Diptera, or true flies, if we classify the families according to habits of the majority of the species in each, we get approximately: injurious families, 10; predaceous families, 11; parasitic family, 1; scavengers, 19. In point of numbers, of individuals in this order, as well as in the Coleoptera, no doubt the injurious will exceed the predaceous; while in the Diptera the scavengers will probably equal all of the others put together.

In the Lepidoptera practically all of the 60 odd families are injurious through the damage done by their larvæ to vegetation, but here again it must be remembered—and the same comment holds for many of the Diptera which we have just considered—that the adult insects are among the most active and frequent visitors of flowers and have a great and beneficial effect on cross-fertilization.

In the Trichoptera the insects of the single family feed upon aquatic plants and have no economic value except as furnishing food for food fishes.

The insects of the single family in the order Mecoptera are indifferent in their economic relations, though probably slightly beneficial.

In the Neuroptera all of the seven families are beneficial through their predaceous habits, with the exception of the Sialidæ, which, since their larvæ are aquatic, may be termed indifferent or neutral, though it has both a beneficial and an injurious relation to food fishes.

In the Homoptera we have nine families, all of which are injurious except that here

and there a species has had a commercial value, like the lac and dye insects.

In the Heteroptera there are 11 families which are strictly plant feeders; 8 are strictly predaceous; 3 are both injurious and predaceous; while the economic value of 13 is more or less doubtful. Most of these last are aquatic and have some value as fish food.

The insects of the single family of the order Physaptera are injurious.

In the Orthoptera we have one family of strictly predaceous habits; one which has a mixed food and is partly injurious and partly beneficial as its species become scavengers; the habits of 1 family are unknown; while in the 4 remaining families the species are all injurious as destroyers of vegetation.

The insects of the single family of the order Euplexoptera are probably beneficial as predatory forms and scavengers.

The single family of the order Mallophaga is injurious, containing parasites of birds and mammals.

In the Corrodentia the habits of the insects of the single family are on the whole of little economic importance, though the species are to be classified in the main as scavengers.

In the Isoptera the forms belonging to the two families are injurious.

In the Order Plecoptera the species of the single family are practically neutral in their economic relations, although they possess some value as fish food.

All of the insects of the single family of the order Odonata may be called beneficial; the adults are predaceous upon other insects and are thus strictly beneficial, but the larvæ may in a sense be termed injurious, since they are aquatic and prey upon other aquatic insects which themselves may be food for fishes.

The insects of the single family of the order Ephemera are of little economic value, except that they are important fish food.

Lastly, the insects of eight of the families of Thysanura are beneficial as scavengers and soil markers, while some of the species of one family are somewhat harmful from the damage which they do in households.

Tabulating the facts thus gained we have the following:

Injurious as feeding upon cultivated and useful plants, the insects of 112 families.

Injurious as parasitic upon warm-blooded animals, the insects of 1 family.

Beneficial as preying upon other insects, the insects of 79 families.

Beneficial as scavengers, the insects of 32 families.

Beneficial as pollenizers only, the insects of 2 families.

Beneficial as forming food for food fishes, the insects of 3 families.

Of undetermined economic importance, the insects of 49 families.

Families containing both injurious and beneficial forms, 22.

The totals are:

Beneficial, the insects of 113 families.

Injurious, the insects of 116 families.

Both, or undetermined, the insects of 71 families.

CONCLUSION.

And now the question is: Are we any nearer the answer of the query in the title of this paper than we were at the start? We have, perhaps, gained by this summary a clearer idea of the economic importance of the class Insecta, and possibly it may appear by this contrasting method that the benefits derived from insects entirely offset their injuries; but we cannot, in our present stage of enlightenment (and I say it with all reverence), complacently and piously adopt, with the good old rector of Barham, the view that insects, with all the lower animals, were created for man's benefit, God permitting occasional injuries, to use Kirby's

words, "not merely with punitive views, but also to show us what mighty effects he can produce by instruments so insignificant, thus calling on us to glorify his power, wisdom and goodness."

Contrast with this view the view of Professor Bailey, in one of his charming essays in the volume entitled 'The Survival of the Unlike:' "We are now prepared to admit that this whole question of enemy and friend is a relative one, and does not depend upon right and wrong, but simply upon our own relationships to the given animals and plants. An insect which eats our potatoes is an enemy because we want the potatoes too; the insect has as much right to the potatoes as we have. He is pressed by the common necessity of maintaining himself, and there is every evidence that the potato was made as much for the insect as for the human kind. Dame Nature is quite as much interested in the insect as in man. 'What a pretty bug!' she exclaims; 'send him over to Smith's potato patch.' But a bug which eats this insect is beneficial; that is, he is beneficial to man, not to the insect. Thus everything in nature is a benefit to something and an injury to something; and every time that conditions of life are modified the relationships readjust themselves."

In these words Bailey, with his accustomed felicity, has expressed the situation admirably. Man is but one of the forms of life struggling for existence, at continual warfare with surrounding forms; but by virtue of his surpassing intelligence—itself as gradually evolved as have been the physical characteristics of any given species—he has overrun the earth, has accommodated himself to the most unnatural environments; he has dominated all other species in nature; he has turned to his own uses and encouraged or hastened the evolution of species useful to him or of useful qualities in such species; he has wiped out of existence certain inimical forms, and is gaining

the control of others. He is the dominant type, and types whose existence and methods of life are opposed to his interests are being pushed to the wall. It is the culmination of a history which has many times repeated itself in past ages. The struggle of other forms of life to accommodate themselves to the conditions brought about by the rapid development of this dominant type is one of the most interesting fields of study open to the biologist to-day. It would seem as if, in man's efforts to make the face of the earth his own, all the complicated elements of life were arrayed against him, and the great and ultimate result of the labor of the biologist in his study of the relations of the different forms of life and the laws which govern their development will be to bring about the absolute control of all other life by man. Thus it is not only the economic worker who looks for immediate results of a practical kind from his labor—the scientific agriculturist, the horticulturist, the economic zoologist, the medical bacteriologist—who should command the respect of even the practical-minded man, but the biologist in whatever field, however restricted it may be, whether he is working towards the understanding of broad principles and general laws, or whether in some narrow corner of research, he is accumulating material which will help ultimately to lead to wider understandings—all are working helpfully and practically towards the perfect well-being of the human race.

L. O. HOWARD.

WASHINGTON, D. C.

ANTI-FRICTION ALLOYS.

M. G. CHARPY, the well-known investigator in this field, publishes in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, for June, 1898, an extensive paper on the 'Travaux de la Commission des Alliages,' of which the following are some of the main points:

The purpose of the investigation was largely that of finding a way of applying to alloys for bearings the tests previously deduced respecting relations of fusibility and other properties. General experience has shown that white alloys, customarily used for bearings in machinery, are much less frequently overheated than those made, as previously common, of bronze, while they are found also to reduce friction something like 20 per cent. In some instances the reported accidents with the two classes of metal are but $2\frac{1}{2}$ with the white metal as compared with 100 with the yellow in ordinary railroad work. Their wear is also but about 0.4 that of the bronze. So long, however, as a layer of oil remains in effective depth, on the rubbing surface, the coefficient of friction is substantially the same with all bearing metals. Flooded journals give immunity from friction, safety from heating and wear, and independence of the nature of the rubbing metals, except so far as their conductivity affects the removal of heat developed by friction.

Charpy gives an extensive table of the composition of various anti-friction alloys as reported by the authorities, including substantially all those reported by Dudley, Ledebur and Thurston. His own investigations are upon alloys of lead and antimony; of lead, tin and bismuth; of tin, copper and antimony; of lead, copper and antimony; of zinc, tin and antimony, and of copper, tin and lead; all of which are studied under compression and wear, and micrographically. Admirable prints are given of the micrographic development, and the 'stress-strain' diagrams, both for the binary and ternary alloys, are exhibited; the writer using the Thurston 'tri-axial' diagram, and the corresponding 'glyptic' representation in the solid, to illustrate his work.* The paper abounds in most inter-

esting and helpful illustrations of these kinds.

He concludes substantially as follows :

(1) All these alloys, when fitted for use as anti-friction metal, exhibit the same general characteristics. They are made up of hard particles set in a soft and plastic alloy. The load is taken by the hard metal, while the friction is reduced by the comparatively low coefficient of friction and by the power which is given by the soft alloy of adapting the loaded surface to the position of the journal and to its deformations. The ternary alloys are thought better than the binary.

(2) The limits of practically useful alloys and mixtures are determined by this method of investigation and the best compositions are identified.

(3) The processes adopted are mainly graphic and micrographic, to ascertain whether the quality is suitable and the composition such as has been found desirable, and compressive tests to ascertain whether it has the needed power of resisting pressure, without serious deformation under ordinary conditions of use. 'Cooling curves' were found very helpful.

(4) Alloys of lead and antimony should contain between 15 and 25 per cent. antimony. Those containing more of this constituent are too hard and those containing more lead are too soft; the one will lead to brittleness and fracture, the other to crushing and cutting.

(5) The copper-tin-antimony alloy of best proportions is considered to be that containing Cu. 5.55; Sn. 83.33 and Sb. 11.11 by weight. It is strong and tough, corresponding with the alloys empirically selected for railroad journals by some railway authorities.

(6) The lead-tin-antimony alloys should contain between 15 and 90 per cent. tin, and

country, has most extensively employed these methods of micrography in the work of his laboratory.

* See Transactions Am. Soc. Mech. Engrs., No. DCCLXXVII., Vol. XIX., 1898. Sauveur, in this

not above 15 or 18 per cent. of antimony. An alloy employed for metallic packing contains Pb. 80; Sn. 12; Sb. 8.

(7) The copper-lead-antimony alloy should not contain above 10 per cent. copper. One tested alloy of good character is Cu. 10; Sb. 25; Pb. 65. It has been used successfully on railway axles.

(8) The copper-tin-lead alloys are the usual bronzes of anti-friction metal makers. The lead is probably a necessary constituent for highest efficiency. They contain from 75 to 90 per cent. copper; 8 to 12.5 per cent. tin, and 0 to 15 per cent. lead. Fluxing with arsenic or phosphorus is usually advantageous, the amount found in such alloy averaging about 0.8 per cent. •

R. H. T.

ANNUAL MEETING OF THE AMERICAN PSYCHOLOGICAL ASSOCIATION.

THE American Psychological Association held its seventh annual meeting at Columbia University, New York City, on December 28-30, 1898. Over fifty members were in attendance at the various sessions, this being the largest number at any meeting since the organization of the Association.

Owing to the number offered, the sessions were entirely given up to the reading and discussion of papers, but the members were present at the discussion before the American Society of Naturalists in 'Advances in Methods of Teaching,' being represented in the discussion by the President of the Association, Professor Münsterberg. Many of the members also attended the reception given by Professor and Mrs. Henry F. Osborn to the Affiliated Societies on Wednesday evening, and were present at the dinner of the Societies at the Hotel Savoy on Thursday evening. At the business meeting Professor John Dewey, of the University of Chicago, was elected President for the ensuing year; Dr. Livingston Farrand, of Columbia University, Secretary and

Treasurer; and Professors J. McK. Cattell, of Columbia University, and H. N. Gardiner, of Smith College, members of the Council.

Besides other business transacted, there was appointed, on motion of Professor J. M. Baldwin, a Standing Committee of Psychological and Philosophical Terminology, consisting of Professors Münsterberg, Cattell, Sanford, Creighton, Royce, Minot and Baldwin. The duties of this committee are to recommend from time to time new terms and choice of alternative terms in psychology and philosophy; to recommend foreign equivalents for translation both into English and into foreign languages, and to keep the Association informed as to the growth of terminology in other departments, especially in neurology.

Professor J. McK. Cattell, Chairman of the Committee on Physical and Mental Tests, reported on the work of the Committee during the year and described the progress in this field in the different laboratories.

Professor Münsterberg, who presided at the meeting read his presidential address on Wednesday afternoon, taking as his subject 'Psychology and History.' Professor Münsterberg argued that the psychological and historical views of human life are necessarily in conflict; for the one the personality is a complex of elements and causally determined; for the other it is a unity and free. He held that claims of recent writers that psychology and history are two coordinated ways of dealing with the same problem are untenable; that the difference between the two is not methodological, but ontological. The materials are different. The material of psychology consists of objects which as such can be described and explained; the material of history consists of subjective will acts which can merely be interpreted and appreciated. Our interest in the two is different. The investigation

of the material of history brings us to a teleological system in which every will act is linked with every other will act and the general fact is not a causal law but a will relation.

The subject of the 'discussion' which followed the address of the President was 'The Relations of Will to Belief.' Professors James and Miller, who were to have taken part, were unavoidably detained from the meeting, and the discussion was carried on by Professors Ladd, Hibben, Caldwell and Armstrong. The first three speakers presented their views on the question, especial reference being paid to Professor James' essay, 'The Will to Believe,' while Professor Armstrong closed the debate with a historical summary of the subject.

Of the regular meetings of the Association for the reading of papers the first was on Wednesday morning and was opened by Mr. E. A. Kirkpatrick on 'The Development of Voluntary Movement.' After describing the case of a young child upon which he based his views, the speaker argued that movements, such as walking, that seem to be learned are in reality largely inherited, and that other nervous and muscular connections are less a matter of experience than is usually thought.

Professor E. B. Delabarre reported certain experiments made upon himself with *Cannabis Indica*, and attributed the effects to the hyperexcitability of the nervous system induced by the drug. There was a gradual increase in sensory, intellectual, emotional and motor activity, lasting about half the total duration of the main influence, and followed by a gradual decrease to normal or below.

Professor George T. Ladd read a paper in which he held that psychology was not making the progress in this country which might reasonably be expected, and held that the hindrances are, in part at least, matters of *personnel* in the body of professional

psychologists. The particular hindrances mentioned by Professor Ladd were, in brief, the excessive scholastic spirit among psychologists and the consequent ignorance of the mental life of the great body of the people, the great number of publications by authors of insufficient training, the injury done to the science in the eyes of the laity by methods of discussion and controversy, the invasion of the commercial spirit and the maintenance of an improper attitude toward the other most closely allied sciences.

In a paper on 'Reason a Mode of Instinct,' Mr. Henry Rutgers Marshall argued that the objective mark of an instinct is that it determines in an organism typical reactions of biological significance to the organism; that opposition to instinct exhibits itself in variation from typical reaction, and is indicated by hesitancy and then choice. Reason is the psychic coincident of the physical process antecedent to choice. Variation and reasoning both appear as reactions of a part of a complex physical and psychical system. Variation is statable in terms of instinct, and hence reason itself must be looked upon as a mode of instinct, the observed opposition between the two being due to the complexity of the organic connections of the phenomena.

Professor Wesley Mills spoke on 'Animal Intelligence and Methods of Investigation,' emphasizing the importance of normal conditions in experimenting with lower animals, and objecting to the recent work of Dr. E. L. Thorndike, on the ground that he had violated this fundamental principle. The speaker further argued in general for greater caution in drawing conclusions from observations on animals.

Professor Mary Whiton Calkins read a technical paper on 'Psychological Classification,' dealing particularly with the attributes of sensation.

On Thursday morning, December 29th, the members of the American Physiological

Society who were meeting in New York were invited to hold a joint session with the Psychologists in the Psychological Laboratory in Schermerhorn Hall, for the reading, by members of both societies, of papers which might have a common interest. This joint meeting was successfully carried out, with President Chittenden, of the Physiologists, in the chair. Professor J. McK. Cattell opened the session with an exhibition of certain new instruments of his own designing, for the study of movement and fatigue, and a brief description of certain researches now in progress in the psychological laboratory at Columbia. Among other instruments was a spring ergometer, intended to replace the Mosso ergograph, and a dynamometer, in which the pressures are continually added and counted, making the study of muscular fatigue and the effect of mental conditions on fatigue possible without elaborate apparatus.

The other psychological papers presented at this session were by Professors Münsterberg, Patrick and Scripture. Professor Münsterberg spoke on the 'Physiological Basis of Mental Life,' pointing out certain fundamental objections to current physiological theories of brain processes, and suggesting several modifications which would account for more of the factors in psychophysiological activity than is now the case.

Professor G. T. W. Patrick reported experiments on tastes and odors made in the laboratory of the University of Iowa upon a subject with complete congenital anosmia. Among other conclusions he drew the following: That what commonly passes for taste sensations, so far as their discriminative or intellectual value is concerned, is the composite result of the mingling of sensations of smell, touch, temperature, sight and taste; the latter, however, playing little or no part in the discrimination of our common foods and drinks. Taste sensations

furnish rather the emotional element in the total conscious effect.

Dr. E. W. Scripture gave a lantern exhibition of his methods of demonstrating the the physiology and psychology of color, and by special invitation Professor Ogden N. Rood, of Columbia University, demonstrated his 'Flicker Photometer.'

Physiological papers were read by Professor F. S. Lee on 'The Nature of Muscle Fatigue,' by Professor G. C. Huber on the 'Innervation of the Intracranial Vessels,' by Professor C. F. Hodge on 'Possible Amoeboid Movements of the Dendritic Processes of Cortical Nerve-cells' and by Professor G. W. Fitz on 'A New Chronoscope.'

At the meeting on Friday morning Mr. J. E. Lough reported experiments made at Wellesley College, on the changes in rate of respiration during mental activity started by visual stimuli. There was in every case an increase in the rate during stimulation and a return to the normal afterward, the amount of the increase produced by a given stimulus corresponding in a general way to the degree of mental activity produced.

Dr. Robert MacDougall described researches now in progress in the laboratory at Harvard, and Dr. E. W. Scripture reported the work at Yale. Among other investigations Dr. Scripture reported interesting results from passing alternating currents of high frequency through the human body, producing practical anæsthesia and analgesia to touch and cold, though apparently not to heat. The speaker called attention to the possible value of this method in producing analgesia for surgical purposes. Dr. J. P. Hylan gave an account of the work in the laboratory of the University of Illinois, and was followed by Dr. G. V. Dearborn, who described experiments on recognition under objective reversal, using chance blots of ink on white cards, arranged in series of ten and reversed in each of the four quadrants and in the mirror, and

always in a plane at right angles to the visual axis. He found that an object is recognized more readily when inverted than when in either of the two intermediate positions, and more readily also than in the erect mirror reversal or in that position inverted.

Dr. Arthur MacDonald reported further measurements of pain and gave tables and results. Two purely philosophical papers were presented, one by Professor W. A. Hammond on the theory of the will in Aristotle's Ethics, and the other by Professor W. G. Everett on 'Ethical Scepticism.' These papers closed the morning session. In the afternoon Professor W. Caldwell read an appreciative criticism of Professor J. Mark Baldwin's recent work on Social and Ethical Interpretation. A paper on the genetic determination of the self, which had been announced by Professor Baldwin, he was forced to abandon on account of illness.

In a 'Study of Geometrical Illusions,' Professor Charles H. Judd upheld the thesis that the underestimation of acute angles and overestimation of obtuse angles, which is a common feature of many illusions, is not a fundamental fact, but is to be explained as due to the false estimation of the length of the sides of the angles.

Professor Margaret F. Washburn spoke on 'Subjective Colors and the After Image,' and Professor Ladd closed the meeting with a description of a new color illusion.

LIVINGSTON FARRAND.

SCIENTIFIC BOOKS.

The New Maryland Geological Survey. Volume I., 1897. Volume II., 1898. Johns Hopkins Press.

The plan and the organization of the Maryland Geological Survey are set forth in the introduction to the first volume of the reports. In many respects they present admirable examples of common sense in scientific work. The business of a State Survey, if successful,

must be conducted so that it nets the people a fair return for their money. It may neither soar to abstruse and doubtfully profitable speculation nor sink to politics for spoils only. Failing to avoid one or the other unbusiness-like extreme, many State Surveys have died. The Maryland Survey appears to have struck a course between Scylla and Charybdis.

According to the organic law the name is the State Geological and Economic Survey. The control is in the hands of a commission, consisting of the Governor and Comptroller of the State and the presidents of two principal educational institutions—of Johns Hopkins University and the Maryland Agricultural College. The commissioners shall appoint as superintendent a geologist of established reputation, who shall nominate for appointment by them such assistants as they deem necessary; and they shall determine compensation of employees and may remove them. The objects of the Survey are defined in six articles, of which three relate to appropriate investigations having practical bearing, two give authority to publish maps and reports, and the sixth confers special authority to consider 'such other scientific and economic questions as in the judgment of the commissioners shall be deemed of value to the people of the State.' Among other sections is one appropriating \$10,000 per annum for the purpose of executing the provisions of the act. This section must be repealed before the appropriations for the support of the Survey can cease.

By this law a board of commissioners, which is equally divided between the educational and executive or political leaders of the State, is given unrestricted authority to carry on appropriate observations for the benefit of the people. The scope is unlimited, their power is absolute, their responsibility is direct.

The Commission organized the Survey to insure practical and thorough work. Professor Wm. B. Clark, of Johns Hopkins, was appointed State Geologist. It was resolved that there should be no salaried officers, all services to be paid at per diem rates for the time employed.

The scope of the Survey was determined to be economic and educational. The economic character was sufficiently prescribed by the law;

but an educational purpose has rarely, if ever, been so frankly assumed by a State Survey. The necessity to enlighten the general public as to the ends of a geological survey, though well understood, is generally stated in an aside.

The position taken by the Maryland Survey gives it strength and a broader opportunity. It will be thought by many who know him that President Gilman has exercised a controlling influence in this as in other wise decisions of the Board.

Strong in its close relations with the Maryland Agricultural College and Johns Hopkins University, the Maryland Survey has sought still further to strengthen itself by cooperation with the scientific bureaus of the National Government. The Agricultural Department, the Weather Bureau and the Geological Survey have met the State Survey's advances cordially, and the work of Professor Clark and his colleagues is supplemented by that of members of the several National organizations.

Maryland undertakes no new task in organizing this economic survey. Exploration and mapping have been in progress since the earliest days of settlement and thus cover more than two centuries and a half. Logically planned, the reports open with an historical account of this progress, which begins with the voyage of Captain John Smith in 1608. Reading the early accounts of the region about the Chesapeake one is reminded of recent descriptions of Alaska or the Philippines. The degree of knowledge expressed is similar. In 1635 it was written of Maryland :

"The Countrey is generally plaine and even, and yet hath some pritty small hills and risings ; It's full of Rivers and Creekes and hath store of Springs and smaller Brookes."

"The Mineralls have not yet beene much searched after, yet there is discovered Iron Oare ; and Earth fitt to make Allum, *Terra lemaia*, and a red soile like Bolearmonicke, with sundry other sorts of Mineralls, which wee have not yet beene able to make any tryall of * * * and to conclude, there is nothing that can be reasonably expected in a place lying in the latitude which this doth, but you shall either find it here to grow naturally ; or Industry, and good husbandry will produce it."

Modern events were perhaps prophesied in the note on Herman's map of Maryland (1670) :

"Certain it is that as the Spaniard is possessed of great Store of Mineralls at the other side of these mountaines the same Treasures they may in process of time afford also to us here on this side when occupied which is Recommended to Posterity to Remember."

The first geological survey of Maryland was authorized by law in 1834. It is interesting to compare that act of the Assembly with the act passed with the same object sixty-two years later. The Act of 1834 authorizes the Governor and Council to appoint an Engineer and a Geologist at salaries of \$2,000 each ; it prescribes the duties of the engineer and even more precisely those of the geologist. The latter shall "make a complete and minute geological survey of the whole State, commencing with that portion which belongs to the Tertiary order of geological formations, and with the southern division thereof, and progressing regularly with the course of the waters of the Potomac and Chesapeake through that region, and thence through the other subdivisions of the State, with as much expedition and despatch as may be consistent with minuteness and accuracy."

By a special section of the act the Geologist is instructed to analyze mineral substances or soils left at his office or residence by any citizen of the State ; he is to report all 'remarkable discoveries,' a command whose phraseology sufficiently indicates the common understanding of a survey's *raison d'être*. The expenses of the Engineer and Geologist are to be paid, "so far as they may be deemed just, equitable and proper, to an amount not exceeding one thousand dollars per annum. But the official services of these gentlemen shall cease at the end of one year, unless the act be re-enacted by the next Legislature.

In strong contrast with the petty control thus assumed by the Assembly of 1834 is the freedom of action granted in 1896, and not less striking is the personal tone of the former act when compared with the impersonal character of the latter one. The one might have been entitled : An act to hamper a State Geologist ; the other has created a State Survey.

The historical account is brought down to

the date of writing by sketches of the work of all existing institutions which are contributing to a knowledge of Maryland's resources. The valuable work of the late Professor G. H. Williams is appropriately set forth at length. The sketch closes with lists of the surveys and maps relating to Maryland made by the U. S. Coast and Geodetic Survey and the U. S. Geological Survey, and these lists are supplemented by excellent index maps of the State, showing the triangulation and the arrangement of map sheets.

Following this historical article by Professor Clark is a second, on the present knowledge of the physical features of Maryland, embracing an account of the physiography, geology and mineral resources. Of this it need only be said that it is concise, complete and accurate, so far as the data now available permit. This report frankly recognizes the existing information concerning the State as the seed from which future knowledge must grow. An excellent geologic map lithographed by Hoen & Co. illustrates the article.

A bibliography and account of cartography of Maryland, by Dr. E. B. Matthews, logically completes the historical portion of the volume and constitutes an important work of reference.

An earnest of the important results which the Maryland Survey is to accomplish is contained in the article by L. A. Bauer on a magnetic survey of the State. Including an account of the history and objects of magnetic surveys, this preliminary report is of broad general interest. Declination and dip of the needle and intensity of the magnetic forces are defined. A history of magnetic surveys and an account of methods follow. There is an extended account of variations of magnetic declination. The distribution of the declination in Maryland is described and illustrated by a map. And, finally, the economic value of the work is set forth in a discussion of the establishment of surveyor's meridian lines.

The second volume of the Maryland Survey reports, when compared with the first, is a demonstration of the wisdom of doing one thing well and the next thing better. Both volumes are superior in utility and appearance to any

State report previously issued. That the Maryland Survey has already won the confidence of the people and the Legislature is shown by the appropriations of \$5,000 to promote topographic surveys and \$10,000 to conduct investigations for betterment in highways. These sums, added to the appropriation of \$10,000 for geology, place in the hands of the Geological Survey Commission annually \$25,000 to be spent for the benefit of the people of the State. That it will be expended in securing authoritative information appears from the contents of the second report.

Dr. G. P. Merrill, an authority on building stones, contributes an article on the physical, chemical and economic properties of building stones in general, with special reference to the needs of the Maryland industry. This article is of general interest, as furnishing information of primary importance to capitalists, quarrymen and users of stone. It is followed by an exhaustive description by Dr. Mathews of the quarry products of Maryland considered with reference to their qualities, accessibility and adaptation. The subject is treated in detail, being classified under the headings: 'Granites and Gneisses,' 'Marbles and Limestones,' 'Sandstones,' 'Slate,' and the 'Building Stone Trade,' and further subclassified by localities throughout the State. The author personally examined each quarry and made his observations with expert knowledge. The report is very beautifully illustrated, not only by the usual photographs of quarries, but also by photomicrographs of the rocks and by full-page colored heliotypes which represent the texture and color of the stone as they appear in a smoothed specimen.

The appropriation of large sums to prepare a topographic map of Maryland affords a reason for stating the objects of such a map, and such a statement might suffice simply as an explanation. But to meet the educational purpose of the Maryland Survey more is required, and this something more is supplied by Mr. Gannett's article on the aims and methods of cartography with especial reference to topographic maps. The methods now in use in extensive surveys were developed by Mr. Gannett and his assistants and are characteristically original.

In their present development they constitute the most practical methods known, because they are the most economic while they are also adequately accurate.

The succeeding article by Dr. Mathews on 'Maps and Map Makers of Maryland' is of much historic interest. Dr. Mathews has ably assisted Professor Clark in his effort to make the Survey of Maryland a success, and to them both, as well as to the Geological Commission, belongs the credit of raising the standard of economic surveys to a grade that few can reach and none have surpassed.

BAILEY WILLIS.

La vie sur les hauts plateaux. Par le PROFESSOR A. L. HERRERA et le DR. D. VERGARA LOPE. Published by A. L. Herrera, Museo Nacional, Mexico. 1899. 4to. Pp. 786. Price, \$6.

This remarkable work won the Hodgkins prize of the Smithsonian Institution, and now, translated from Spanish into French, is published in beautiful form through the munificence of President Diaz, of Mexico, to whom it is appropriately dedicated.

Professor Herrera, as the best type of a man of science, is an honor to our sister republic. His epoch-making ideas on the subject of museums have been very influential in France.

The present important volume is on matters for whose investigation the authors are most advantageously situated, having lived that life on the high plateaux of which they so ably treat.

The book opens with a chapter on the relief of both continents; the distribution of the great plateaux; their relations, ethnographic and hygienic. Chapter II. is on the vertical distribution of vegetable life and the phenomena of adaptation in the species of high altitudes. This is particularly rich in regard to the flora of Mexico and especially the Valley of Mexico. The action of the increased intensity of the sunlight is exhaustively studied.

Chapter III. devotes two hundred pages to the vertical distribution of animals, with the phenomena of adaptation, and in particular the influence of rarefied air. A study is made of mountain sickness as exhibited by animals.

Chapter IV. passes to the vertical distribu-

tion of mankind. Chapter V. is devoted to anthropometry and physiology of man at high altitudes. Worthy of note is the part on digestion, illustrated by considerations on the food supply of the City of Mexico. Chapter VI. is very short, treating of atmospheric pressure in geologic epochs and its supposed influence on organic evolution. Chapter VII. is largely taken up with experiments on the action of rarefied air. Chapter VIII. is on combustion and fermentation at high altitudes. Book II., applications, begins with Chapter IX., on typhus and scrofula at high altitudes. But of intense interest, of universal importance, is the matter of Chapter X., on the treatment of tuberculosis by altitude.

Statistics prove that the maximum of mortality from this dread destroyer pertains to low regions, the minimum to high. In more than 60 cases the curve of mortality rises as that of altitude descends.

In Mexico, even among the poor and the soldiers, there are less deaths from tuberculosis than in the low regions of Europe. For a thousand victims in regions below 500 meters there are only 255 in regions above 500. In Mexico out of 100 persons the parents of 3 will have died of tuberculosis; in Lima the parents of 18.

A residence at high altitudes is indicated for persons with hereditary or any other predisposition toward tuberculosis; for persons with defective chest-conformation or respiratory capacity, or in whom inflammatory affections have been incompletely cured. Even for animals the data show at high altitudes a certain immunity against tuberculosis.

In 1885 of 73,000 cattle killed at the general abattoir of the City of Mexico only 45 were tuberculous, while in England the proportion rises as high as 20 in 100.

It is known, say our authors, that in tuberculosis the climate of high altitudes, even for those far advanced, prolongs life. What is it, then, that can diminish the number of cases or help those already attacked? Our authors attack this momentous question in the true spirit of experimental science. The illumination by the solar rays attains its maximum at high altitudes, and experiment proves that light

kills the bacilli and their spores with incredible rapidity. The dryness and cold also work against the existence of microbes.

But how can the rarefied air influence favorably pulmonary tuberculosis? After prolonged experimental study our authors sum up their results in certain theorems, which are discussed separately: (I.) Lessening pressure increases the circulation of air in the lungs, dilates them and obliges torpid parts to functionize. (II.) Lessening pressure determines a greater quantity of blood to the lungs. (III.) Lessening pressure, dilating the lungs, permits a uniform distribution of blood, makes regular its circulation and thus combats congestion. (IV.) Lessening pressure diminishes intrapulmonary tension in general and in particular intravascular tension. (V.) Augmentation of red globules and white globules. (VI.) Desiccation of mucous surfaces. The favoring of evaporation.

Numerous experiments on animals were followed by the actual treatment of tuberculosis by rarefied air, diminution of pressure. The results were highly encouraging and remarkable. Of the 13 healthy persons and numerous consumptives submitted to the action of rarefied air not one experienced the alarming symptoms described by P. Bert (*Pression barométrique*, p. 750). The experiments of Paul Bert having been credited, put a stop to all progress in these matters, and the whole world is indebted to Herrera and Lope for removing the embargo and smashing the tabu.

Of 13 cases of pulmonary tuberculosis treated by baths of rarefied air only one lost weight, one remained stationary, eleven increased most notably in weight, one increasing 300 gr. each day, one increasing 28 gr. each day during 4 months of treatment.

Our authors hold that the acclimation of plants, animals and man to the atmospheric conditions of high altitudes is rapid and in general perfect, without the slightest loss of vigor.

The vegetable kingdom reaches its maximum at high altitudes. As for mere size we need only mention the great tree of Tula and the tree of Montezuma. Any limitation is question of temperature, not atmospheric density. Species ascend the summits as they approach the equator. This is a pregnant hint for scientific

agriculture. The more intense light of the altitudes, as also the dryness and decreased pressure, influence favorably the formation of chlorophyll, the decomposition of carbonic acid, the formation of amidon, the movement of protoplasm, the multiplication of epidermic cells, the force of transpiration, the absorption of oxygen.

As for animals, the fact that many species emigrate periodically to high altitudes and flourish there proves that often acclimation is exceedingly quick. Mammals are subject to 'mal des montagnes' and then must undergo a period of acclimation more or less troublesome. The symptoms are analogous to those in man. But the result is perfect adaptation. Longevity is not decreased, nor fecundity, nor secretions (*e. g.* milk).

In the blood the number of red globules augments with the altitude. There is an exact proportion between this number and the barometric pressure of the locality. This is so little known that in Mexico reputable physicians have declared patients not suffering from anemia despite most evident symptoms, simply because microscopic examination of the blood disclosed the number of the globules considered as normal in Europe! The tension of the blood diminishes with the altitude. On the other hand, the intensity of intra-organic combustion, the temperature, the colorification is exactly the same for inhabitants of the City of Mexico, at an elevation of 7,350 feet, as for man at the low European levels.

This whole book is so unexpectedly rich in scientific contributions of the most momentous practical importance that no one working in any of the subjects touched can afford to be without it, and our sister republic deserves to be publicly congratulated on its appearance.

GEORGE BRUCE HALSTED.

AUSTIN, TEXAS.

BOOKS RECEIVED.

A History of Physics. FLORIAN CAJOREL. New York and London, The Macmillan Company. 1899. Pp. viii + 322. \$1.60.

The Microscopy of Drinking Water. GEORGE CHANDLER WHIPPLE. New York, John Wiley & Sons; London, Chapman & Hall, Ltd. 1899. Pp. xii + 300 and 19 plates.

Who's Who, 1899? Edited by DOUGLAS SLADEN. London, Adam and Charles Black; New York, The Macmillan Company. 1899. Pp. xx + 1014. \$1.75.

Laboratory Manual in Astronomy. MARY E. BYRD. Boston, Ginn & Co. 1899. Pp. ix + 273.

Experimental Morphology. Part II. Effect of Chemical and Physical Agents on Growth. CHARLES BENEDICT DAVENPORT. New York and London, The Macmillan Company. 1899. Pp. xviii + 508.

SCIENTIFIC JOURNALS AND ARTICLES.

American Chemical Journal, February: 'On the Constitution of the Salts of Imido-Ethers and other Carbimide Derivatives,' by Julius Stieglitz. 'On the Hydrochlorides of Carbo-phenylimid Derivatives,' by H. N. McCoy. 'On the Solubility of Argentic Bromide and Chloride in Solutions of Sodid Thiosulphate,' by T. W. Richards and H. B. Faber. From a study of the solubility and effect upon the freezing points of solutions caused by these salts certain conclusions have been drawn as to the probable nature of the substances present in solution. 'Note on the Spectra of Hydrogen,' by T. W. Richards. The author considers the presence of the red spectrum to be due to a breaking-down of water vapor forming atomic hydrogen, which gives the red spectrum. If the gas is perfectly dry the white spectrum alone is obtained.

J. E. GILPIN.

THE first number of *Bird Lore*, edited by Mr. F. M. Chapman, and devoted to popular ornithology, has just appeared. As the official organ of the Audubon Society, and in appealing to young readers as well as old, *Bird Lore* essays to cover a new field. The frontispiece is a view of John Burroughs at 'Slab Sides,' and the first article, 'In Warbler Time,' is from his pen. There are two articles illustrated by photographs from life, by Dr. T. S. Roberts and H. W. Menke; Miss Isabel Eaton has a department for teachers and students, and Miss Florence A. Merriam one for young observers; Notes, Reviews and Editorials follow; while the Audubon Department, edited by Mrs. Mabel Osgood Wright, concludes the number.

WE have received the first number of *The School World*, published in Great Britain, by Messrs. Macmillan & Co., and addressed especially to

teachers in the secondary schools. The first number presents an interesting table of contents including articles on 'The Teaching of Algebra,' by Professor G. B. Mathews, F.R.S.; 'Physical Observations of Brain Conditions of Boys and Girls in Schools,' by Dr. Francis Warner; 'Bimanual Training in Schools,' by Mr. H. Bloomfield Barry; 'Elementary Experimental Science,' by Professor R. A. Gregory and Mr. A. T. Simmons; and 'Current Geographical Topics,' by Dr. A. J. Herbertson.

THE Annual Report of the Director of the Field Columbian Museum for 1897-98 notes good progress, particularly in the Departments of Anthropology, Geology and Botany. Two of Mr. Akeley's fine groups have been added to the exhibition series, one of the Oryx and one of Waller's Gazelle, the latter very striking from the pose of the principal figure and from the extreme length of neck and limbs obtained by these animals. One of the plates in the report shows the large model of the moon recently noticed in SCIENCE. The Director notes that special attention has been given to what he aptly terms the 'highly important but uninteresting and endless labor' of cataloguing, inventorying and labelling

SOCIETIES AND ACADEMIES.

THE BIOLOGICAL SOCIETY OF WASHINGTON.

THE 300th regular meeting of the Biological Society of Washington was held January 14, 1899, President Frederick V. Coville in the chair. Brief notes were presented by the following members: Ashmead, Bailey, Pollard, Erwin F. Smith, Chesnut and Cook. Mr. Ashmead exhibited specimens of a very rare South American wasp (*Chirodamus*), the type of which was secured by Charles Darwin during the voyage of the 'Beagle.' The new specimens were secured by the U. S. Fish Commission and belong to the National Museum.

Mr. Vernon Bailey described a case of protective coloration in *Ochotona*, a coney native to the mountains of California. One of the broken pieces of the rocks among which the animals live was shown in comparison with a stuffed specimen. Mr. Chesnut submitted photographs and fruits of the California Laurel

(*Umbellularia californica*), a small tree of the olive family. A volatile oil is distilled from the leaves and used for medicinal purposes, while the fruits are eaten by the Indians after being roasted to destroy an acrid principle which they contain.

In the regular program Mr. C. L. Marlatt explained the difficulty and confusion which has appeared in connection with previous attempts at designating numerically the broods of the Seventeen-Year Locust, or Periodical Cicada. This insect presents two distinct races, or subspecies, the more southern of which has a thirteen-year period. Mr. Marlatt proposes to use the Roman numerals from I to XVII for the seventeen-year broods and then continue from XVIII to XXX for the thirteen-year series, thus providing a fixed designation for every possible brood. Preceding nomenclatures of the subject were compared with the new suggestions by means of charts. The paper was discussed by Messrs. Howard, Lucas, Gill, Waite, Ashmead and Cook.

Dr. E. A. de Schweinitz explained the practical working of the serum treatment for swine plague and hog cholera. In the previous season (1897) about 200 animals were treated, with a loss of about 20 per cent., while of the recorded cases of uninoculated animals about 80 per cent. died. During the past season the treatment was given to about 2,000, with a loss of about 23 per cent., while of 4,000 untreated about 40 per cent. died. The slightly greater percentage of loss this season is explained by the fact that the conditions of the experiment were not as carefully controlled. The difficulty of diagnosis renders it desirable to use a mixture of the serums prepared for the two diseases.

Dr. Erwin F. Smith discussed 'The Effect of Acid Media on the Growth of Certain Plant Parasites.' Extended experiments with several bacterial diseases of plants demonstrate that some species of these are exceedingly susceptible to an excess of acid in the culture medium. The very slow progress of some such diseases was explained by the fact that they are limited at first to the vascular system, the fluids of which are alkaline, while those of the parenchyma are acid. Some of the germs refused, in

fact, to grow at all in the media prepared with the juices of their own host-plants, until the acidity had been artificially neutralized, while in others growth was greatly retarded. A chart was exhibited showing the comparative reactions of the various species studied, with reference to a definite scale of acidity and alkalinity.

O. F. COOK,
Corresponding Secretary.

MEETING OF THE NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY.

THE January meeting of the New York Section of the American Chemical Society was held on Friday evening, the 13th ult., in the Assembly Hall of the Chemists' Club, 108 West 55th street, Dr. Wm. McMurtrie presiding.

An arrangement for holding the meetings of the Society regularly in the club building was announced and ratified by unanimous vote. Reports were made showing that the funds contributed for the expenses of the midwinter meeting had been sufficient; that the library had been moved to the club rooms, where it was undergoing classification and arrangement, and that the resident membership had reached one hundred, and the non-resident nearly, if not quite, as many more.

The following papers were read: 'Determination of the Bromine Absorption of Fats,' P. C. McIlhiney; 'Indicators,' John Waddell; 'Exhibition of Apparatus for Washing Precipitates,' etc., W. D. Horne.

Mr. McIlhiney recommends the bromine number instead of the iodine number for identifying oils and fats, on account of the greater rapidity of reaction, greater stability of the bromine-carbon tetrachloride solution both before and during use, and the want of differentiation by iodine, between addition and substitution compounds in the reaction.

Mr. Waddell showed some very pretty experiments illustrating the behavior of indicators, and explanatory of their adaptability to acid or alkaline reaction, according to their respective constitution.

Phenolphthalein, a weak acid, reacts red by dissociation in presence of a strong alkali; in presence of ammonia and alcohol the reaction

may be restrained and again developed by addition of water.

Methyl orange, cyanine and coralline were similarly demonstrated.

A letter was read from the General Secretary stating that "at the closing session of the mid-winter meeting at Columbia University, December 28th, by unanimous vote, the cordial thanks of the Society were extended to the New York Section for the bountiful hospitalities of the Section, which were so heartily enjoyed by the members of the Society during the eighteenth general meeting."

DURAND WOODMAN,
Secretary.

DISCUSSION AND CORRESPONDENCE.

REPLY TO CRITICS.

SUPPOSE a house just finished is empty; suppose that it is painted inside and out so as to conceal from vision everything but the paint. Suppose I come upon such a house for the first time and consider it a body of paint, for paint is the only thing that appears at first. In time I discover that it is made of bricks. At first it had the appearance of paint; now it has the appearance of paint and bricks. After further investigation I find that it is partly of wood, for wood appears in its structure. Now, I conclude that it is paint, bricks and wood. By further investigation I find that it is composed partly of iron. Now, I consider it as paint, bricks, wood and iron. Then I might investigate paint, bricks, wood and iron to discover their chemical constitution and the biological history of wood, and new facts would appear. I might go on indefinitely to show how new things are discovered in the building, both in structure and in purpose, and the new things discovered will appear to me. Those already mentioned are enough for this illustration.

Common sense says that paint is paint. The metaphysician says that paint is appearance; that there is no paint as paint, or at least all we know about it is appearance. The same may be said with regard to the bricks. Common sense says bricks are bricks, whether they appear or not; the metaphysician says the bricks are only appearances. Common sense says there is wood, whether it appears or not; the

metaphysician says no, it is only appearance. When we discover the iron, common sense says there is iron in this structure, whether it appears or not; the metaphysician says no, there is only appearance.

Let us get a learned name for appearance. Let us call appearance 'phenomenon,' for that is the Greek word meaning appearance. Now, common sense says that paint, bricks, wood and iron are paint, bricks, wood and iron, respectively, and that appearance is appearance; but our metaphysician says that all of these things are only appearance and we call appearances phenomena; therefore, this house, with all its appearance, is only a concatenation of phenomena. Ofttimes it is asserted that the world is a phenomenal world. Those who make this assertion believe that the world is only appearance. Common sense says that all things of the world exist and manifest themselves by appearance, but that they exist whether they manifest themselves or not. Metaphysic says that the things of the world do not exist as they appear, but that their substrates exist, and that these substrates manifest properties which are not the things themselves. The properties are only illusions—there is no iron, but there is a substrate of iron which manifests certain attributes which are illusions.

In modern times there are two ways in which these supposed illusions are explained. In one way the attempt is made to show that the substrate of things is psychosis or abstract mind; the other is the attempt to explain that the substrate is force or motion. Thus, metaphysicians may be classified as idealists and not materialists.

Common sense says that we may know a body imperfectly and by investigation cognize more and more about it, and, however, simple a body it may be, we may, by investigation, learn very much about it and still not know all.

The idealist says this is true, but by further investigation everything will turn into appearance until we resolve the body into a substrate, and its substrate will be found to be psychosis, which is timeless and spaceless.

The materialists say we know more and more about a body until we resolve it into motion or force, some holding that force creates motion, others that force is a mode of motion; so that

this school is divided into two classes—those who believe force to be the substrate of bodies, and those who believe motion to be the substrate of bodies. Those who believe that force is a substrate believe that force is attraction and repulsion; those who believe that motion is the substrate believe that attraction can be resolved into repulsion and hence that force is a mode of motion.

The idealist believes also that force is attraction and repulsion, for this seems necessary to his doctrine that psychosis is the substrate of phenomena.

In *SCIENCE* for January 27th two eminent men review my little book on 'Truth and Error.' One seems to be an idealist, for he is marked with the paint-pot of this philosophy, though he repudiates it. The other seems to be a materialist as the term was defined in the book. Of course, the terms used do not characterize their theology or their religion, but only their philosophy. The philosophy of the second writer would be characterized better if it were called dynamism; but the popular designation is materialism, and the use of the term dynamism would probably offend Mr. Ward. Mr. Ward is the most illustrious champion of this philosophy in America, and he has written a work on this subject, entitled 'Dynamic Sociology,' which is dynamic philosophy applied to sociology.

During the last decade of this century great activity has been developed in scientific psychology. The new science is confronted with this problem, which is solved in the way I have tried to indicate. All psychologists are drawn into a whirlpool of disputation, and those scientific men engaged in other departments of research often drift into it.

Usually the idealist sneers at a philosophy of science, for 'science deals only with phenomena,' mere appearance—and philosophy deals with the substrate, the thing in itself—psychosis. Dynamism always advocates a mechanical philosophy when its votaries attempt to philosophize, as Ward has done and as Spencer did before him.

In the same number of *SCIENCE* to which reference has been made there is a review of Mivart's book, probably from the standpoint of

a dynamist, but perhaps from the standpoint of an idealist, for this philosophy is of many kinds. Notwithstanding the denial by the idealist of a possibility of a philosophy other than idealism, the warfare between the two philosophies is rife, and at the present day is the subject of disputation, as evolution was the subject a few years ago. Every new publication on the broader aspect of science takes up the gauntlet for one or another of these subjects. Now, I believe that these metaphysical philosophies are mutually destructive, like the cats of whom Mr. Brooks speaks; yet I believe that both contain an element of truth, and that the Kantian doctrine of antinomies, which was elaborated into a doctrine of contradictories by Hegel, is a fallacious logic.

Of course, I do not expect to please the idealist or the dynamist, nor do I expect to kindle the love of those who believe that all philosophizing is in vain, but of this class there are comparatively few. There are engaged in scientific research many men who cultivate a special field and who attempt to harmonize opinions only within that field. There are others who survey larger fields and make wider attempts to arrive at congruities, and there are still others who attempt to make all fundamental doctrines of science congruous, and this is what I have attempted to do in my book.

Consciousness and choice, as the fundamental judgment, certainly inhere in animals, and I have proposed as an hypothesis worthy of consideration that all particles have these elements of judgment. Besides animals there are other bodies in the universe; these are molecules, stars, rocks and plants. In the science of chemistry it is universally recognized that there is a phenomenon in chemical reaction which is called affinity and which eminent chemists believe to be choice. The late T. Sterry Hunt was an advocate of this doctrine. If there is choice of one particle for another there must be consciousness, and this is the doctrine held by Hunt. I merely cite the example and affirm that there are many such chemists. Chemistry is not my special field of investigation, but the doctrine which I learned from chemists and which has been advocated by many others, especially physicists, like Herschel, is taken by

me as an hypothesis to be applied in the new science of psychology, which I do try to cultivate.

I have already set forth that choice is the relational element which corresponds to the essential element—consciousness. Now, by this hypothesis, consciousness inheres in every particle of matter. It does not inhere in bodies themselves as such, but only in their several particles, unless they are animals, for both require an organization for the faculties of mind in order that they should have judgments and concepts. The faculties of mind do not exist in molecules, stars, rocks and plants as bodies. The element of consciousness, together with the element of choice as inference, is exhibited only in the particles of what I call mechanical bodies to distinguish them from animal bodies.

In molecules we have the affinity of the particles, but the particles themselves are incorporated only as numbers. The many particles constitute the organ of the one molecule. Hence chemistry is the science of kinds, but of natural kinds as distinguished from conventional kinds employed by man in the arts. In the molecules we discover a discrete degree of incorporation and organization, because in nature incorporation or evolution is accomplished in stages by properties.

The molecule has not consciousness as a body or kind, but it has consciousness in its several particles. Here we must understand the distinction between organization and incorporation. When we consider incorporation we consider the one body; when we consider organization we consider the many particles of the one body. Organization and incorporation are thus reciprocals. When we consider organization we consider the relation of parts to one another; when we consider incorporation we consider the whole body. The incorporation of a molecule is by the affinity of its particles, and the particles are the organs of the molecule, and they make of the molecule a new kind of substance. Modern chemistry recognizes this fact, for it is taught that when molecules combine with molecules to make molecules in a higher order or kind, the combination is of ultimate particles and not a mere juxtaposition of constituent molecules. So I interpret the teach-

ings of the new chemistry. For example, solution is now held to be chemical action and to involve affinity, and is not a mere mechanical mixture of the matter held in solution. This molecule is a body with organs; as particles they perform the function of incorporation for the molecule.

The nature of incorporation and organization may be illustrated. A hundred persons may meet to organize themselves into a society. They organize by first electing a president, the executive officer who governs the body; then they elect a secretary, who is the memory of the body; they may elect a treasurer and other officers; I need not extend the subject beyond the president, secretary and treasurer. Now, a group of members constitute a body organized with a president and secretary. In this manner the hundred individuals become one body. In the same manner in every body of nature—molecules, stars, rocks, trees or animals—there is an incorporation which is effected by organization.

The particles of the society are its individual members; every one has consciousness, but the body itself has no consciousness; so the molecule has consciousness in its particles, but there is no consciousness by the molecule. In nature all the particles of a body are organized; but in social bodies all the members become the body, and every one is an organ of the body.

In stars, kinds of molecules are incorporated into forms as globes; the kinds thus become the organs of form. Here we have another discrete degree of incorporation or evolution. While the forms as bodies or stars are considered when we consider the incorporation, the parts of the body as molecules are considered when we consider its organization. In the stars there are no organs of mind, but there are organs of form which are molecules, and in the molecules there are organs of kind which are the particles. So the star body has consciousness and choice only in its ultimate particles, for it has as a body no organs of mind.

In rocks, forms are incorporated as forces in which stresses and strains are produced. The forms are organs of force. Here we have a third discrete degree of incorporation and organization. To see how this incorporation is

effected by organization we must consider the spheres of geonomy. They are the centosphere, lithosphere, hydrosphere, atmosphere and ethrosphere. These are organs of stress and strain which cooperate with one another in producing a succession of changes. Strains are set up in one geonomic sphere which produce stresses in another, and thus we have organs of force. These organs of force are forms, so that incorporation implies organization, and organization implies incorporation. Here we have no organs of mind; but we have organs of force, which are forms, and organs of forms, which are kinds, and organs of kinds, which are ultimate particles.

Plants are incorporated as causations in which an antecedent is followed by a like consequent. The child, or consequent, is like the parent, or antecedent, thus developing heredity. The forces now are the organs of causation, and we have a fourth discrete degree of incorporation and organization. Still, there are no organs of mind, but only organs of force. The forces have organs of form, the forms have organs of kind, and the kinds have organs of particles; consciousness and choice, therefore, still inhere only in the particles.

Animal bodies are incorporated as minds, and the organs of minds are causations. Here we have a fifth degree of incorporation and also of organization. With bodies incorporated with organs of mind, which are causations, and with bodies of causation incorporated with organs, which are forces, and with forces incorporated with organs, which are forms, and with forms incorporated with organs, which are kinds, and with kinds incorporated with organs, which are particles, all of the properties of matter are incorporated. Now, the animal body has consciousness because it has organs for the function, while the particles themselves have consciousness. Thus the body has consciousness as a body, as well as the particles, severally, of which it is composed. All of the mechanical bodies have consciousness and choice, but only in their particles; but animal bodies have organized consciousness, which is mind.

This is the conclusion we reach: Molecules, stars, rocks and plants have consciousness and choice only in their particles, but in animals

consciousness and choice are organized as mind.

Hegel taught in his *Phenomenology* that every word, whenever used, has all its meanings, and he proceeded on this theory in the development of his logic. Mr. Ward seems to hold the same doctrine. I hold that whenever a word used in science is fundamental it should be used only in one sense, and this one sense should be retained throughout the discussion. Let me illustrate this: In metaphysic the word *quality* is used as synonymous with *property*; sometimes it is used to signify all of the properties and sometimes only one of them. Kind, as I have shown, is one of the properties, and it is very often used as a synonym for kind. I have tried to show in this book that it is used also to show the relation of bodies in their properties to human purposes, which relations are always either good or evil depending upon the point of view. Now, I have attempted and succeeded, as I believe, in using three terms for these three different meanings: *Properties* for the name of attributes that inhere in the object; *kinds* for the name of one property in all its degrees of relativity, and *qualities* to designate those attributes which arise through the relation of properties to purposes. I use the word *attribute* as a generic term which has two species—qualities and properties; and each of these species is again composed of five subspecies. This is offensive to Mr. Ward, not only in this particular case, but in all similar cases. In the book under consideration I have coined very few words, but I have tried in all fundamental cases to use a word always with the same meaning. There cannot be a science of psychology until its terms are used with constant meanings.

In folklore we often find seven to be a magical number; in the same manner we find nine and other numbers are considered magical—that is, they have occult meanings. The origin of these meanings goes back to savage cosmology. Now, Mr. Ward supposes that I use the number five as if it were magical. But let me assure him that the magic is not in the number. If I pay five dollars to every one of a hundred men because of labor performed, I shall not be accused of using five as a magical number, but

my conduct will be interpreted as my judgment of compensation. The significance of the terms used depends on the fact that there are five essential constants of matter found in every particle of the universe; these are unity, extension, speed, persistence, and consciousness. If the hypothesis that affinity is consciousness and choice fails, and affinity is still unexplained and consciousness is found only in animal bodies, then there are but four essentials in inanimate matter, while there are five in animate matter, and whenever a new animal body is evolved a fifth essential is evolved.

If the five essentials of properties are found in every body this should appear not only as affinity, but it should appear in a series in all bodies. This I have tried to show. I have called the essentials *concomitants*, and this term seems to offend Mr. Ward, but the term concomitant is used in the same sense in all modern and scientific psychology. Again, I have tried to show the nature of reciprocity; as, for example, when I set forth that quantities or properties that can be measured are the reciprocals of categories, or properties that can be classified. When I come to the second volume I shall greatly multiply these series and shall then systematize them into an argument; but I shall try not to make a pentalogic series where none exists, as Mr. Ward has done in the tables which he thinks he has compiled from my book. I find scientific men marshalled in three camps—one as champions of idealism, another as champions of dynamism, and a third rejecting all philosophy as vain. I have begun on the attempt to propound a Philosophy of Science.

J. W. POWELL.

ARTIFICIAL DREAMS.

TO THE EDITOR OF SCIENCE: Maury and some others have, to a certain extent, experimented on artificial dreams, but, at my instance, my students, Messrs. Matthews and Morley, undertook a series of experiments which may have some value in further illustrating the subject and pointing the way to further work. The method employed was for the one at an early hour in the morning to stimulate sensation in the other for a brief period, often 30 seconds, and then waken the dreamer, who at

once recorded the dream. In general, the dreamer did not know beforehand what stimulus was to be applied.

The olfactory element in dreams being little recorded by experimenters, particular attention was paid to this point. Smell was slightly stimulated with heliotrope, and visual images mostly resulted, but in ten cases the dream was also olfactory, twice the dream being of a bunch of *Violets* and of smelling them. In a very strong stimulation of heliotrope the dream was of being choked with smell of perfume. This dream was in its early part composed of remarkable and vivid visual images. The dreamer flew on an air-ship through a snow-storm, and then over a country covered with white enamel and filled with white elephants, one of which pulled down the air-ship but soon released it, and then the whole herd flew off 'like so many butterflies.' This imagery has the characteristic quality of opium dreams.

In taste stimulation by salt and water there was a dream of eating olives.

In stimulating hearing repeatedly with a middle C tuning fork, within an interval of two weeks, a visual-auditory dream was repeated in 'every detail.' A fork in a lower octave gave dream of hearing fog horn, but no visual image. Another time it was the roar of a lion, but no visual image.

The record gives for temperature stimulation 2 pure temperature dreams, and 3 visual and temperature; for pressure stimulation 2 visual and pressure, for smell stimulation 1 pure smell and 6 pure visual and 10 visual and olfactory; for hearing stimulation 7 pure auditory, 6 visual and auditory.

These reports suggest that artificial dreams may be divided into three classes: First, the simple dream, where the stimulus is removed at the least sign of reaction, and the consequent dream is usually vague and momentary. Second, the cumulative dream, where the stimulus is continued and made to increase to even the highest point of excitation, and the dream has a definite intensifying development till the waking point. (An interesting dream would probably be produced by a metronome brought nearer and nearer, either directly or through a tube connected with the dreamer's ear.) The

third class is the complex dream which may be determined by different kinds of stimuli successively applied. These reports also suggest a practical matter that those who find dream pleasures a necessity, as the opium eater, might obtain a large measure of such pleasures by perfume and other stimuli which do not leave unhealthy reactions.

As to my own dreams I may mention a few facts which may be suggestive. My dreaming is commonly of places and persons which are totally unknown, but, of course, the types are familiar. I often dream of being in a crowd and studying faces which I have never seen before. Similarly I dream of being in a bookstore and picking up new books which I have never seen, and reading many pages, and looking at strange pictures. I once awoke from a vivid dream of this sort, and was able to recall several sentences, and to notice that they were far from my own style of writing, and had an individuality of their own which I could not recognize. But all this merely means that those in whom the constructive imagination is strong exercise it freely in sleep.

A singular case of dream stimulation is this: I dreamed of being in a strange hilly country, and a man appeared driving a tandem. In vain he sought to get up the hills, and the horses became so ludicrously tangled that I burst into loud laughter; this was heard in another room. In my laughter I heard other voices laughing, all from a single direction, but there was no visual image. It is highly probable that my dream of hearing others' laughter was stimulated by hearing my own laughter.

Maury makes the 'embryogeny of the dream' to consist in 'hypnagogic hallucination,' that is, in the stage of waking just previous to sleep visual and auditory hallucinations occur which are carried into sleep, but it appears to me that he lays much too great stress on the point. I noticed the other morning during a succession of cat-naps that the formation was not in any wise hallucinatory. Awake for a few seconds I thought of dressing, and had the images of the process but not hallucinatory, but knowing them to be ideas to be realized, but the senses quickly falling asleep, these images constituted a dream reality, I was really dressing. Very

commonly our last waking thoughts turn into dream without any hallucinatory stage.

HIRAM M. STANLEY.

LAKE FOREST, ILL., January 23, 1899.

TROWBRIDGE'S THEORY OF THE EARTH'S MAGNETISM.

IN an article entitled 'The Upper Regions of the Air,' in the January number of the *Forum*, Professor John Trowbridge proposes a new theory to account for the phenomena of the earth's magnetism, of the northern lights and of thunder storms.

His theory, briefly stated, is that those waves of energy coming from the sun whose wavelengths are of the order of those concerned in the X-ray phenomena are completely absorbed by the atmosphere and transformed into electric and magnetic energy in the upper regions of the air, and that being thus transformed they fail to manifest themselves as light at lower altitudes. According to Perrin and Winkelmann, the X-rays have the property of communicating an electric charge to conductors. "If, therefore, X-rays reach the earth from the sun they are competent to give an electrical charge to our atmosphere. The side, therefore, of the earth turned toward the sun would receive a charge in the upper good-conducting regions of the air. This charge would tend to dissipation, and there would be a flow of electricity toward the side of the earth not turned to the sun. The rotation of the earth on its axis from west to east would bring forward at each revolution fresh regions of the upper air to receive the electrical charging from the sun. There would be an accumulation of electricity on one side of the earth and a diminution of electricity on the other. The conditions of the equalization of the electrical charge, or the flow of electricity, might be determined by the direction of rotation of the earth. If this flow took place from east to west, just opposite to the direction of rotation of the earth, and were sufficiently powerful, it would produce the magnetic north and south poles. It has been found that air submitted to the action of the X-rays continues for some time to manifest their influence. We should, therefore, expect a fall of electric pressure between the regions just entering into daylight

and those in the full glare of the sun. This condition would direct the resulting electric current from east to west, or in the direction opposite to that of the earth's rotation.'

The author says we have no good theory to account for the earth's magnetism unless we are ready to accept the one he has proposed. Let us see, then, how the well-known magnetic phenomena of the earth are accounted for by this theory.

First. The north end of the compass needle points approximately toward the north. Applying Ampere's rule to Trowbridge's currents flowing in the upper regions of the air from east to west we find that the north end of the needle would point *south*. Hence the author's currents must be reversed, *i. e.*, they must flow from west to east, or in the *same* direction as that of the earth's rotation.

Second. The north end of the dip needle points down in our latitude; hence applying Ampere's rule again, the electric currents must go in the clockwise direction around the needle, or, in other words, must proceed from east to west, or contrary to the direction of the earth's rotation. We should have, then, here a peculiar state of things. In order to satisfy the phenomena of the horizontal needle, Trowbridge's currents must go from west to east; to account, however, for the known facts of the dipping needle, they must simultaneously go in a contrary direction.

In short, if electric currents produce the observed phenomena of the compass and of the dip needle they cannot be in the atmosphere, but must be inside the earth's crust and proceed from east to west. Let the author apply Ampere's rule to these currents and he will find that they will now completely represent the known magnetic phenomena.

The fact that the causes of the earth's magnetism must be almost entirely *within* the earth's crust was shown mathematically by Gauss half a century ago and has been amply verified by the recent investigations of Schmidt. His elaborate mathematical analysis has resulted in the following conclusions:

The earth's magnetic force consists of three parts, viz: (1.) The greatest part; this is to be referred to causes *within* the earth's crust, and

possesses a potential. (2.) The smallest part' about 1-40 of the entire force; this is due to causes *outside* the earth's crust, and likewise possesses a potential. (3.) A somewhat larger part than the preceding; this does not possess a potential, and, in consequence, points to the existence of vertical earth-air electric currents. These currents amount, on the average, for the entire earth's surface, to one-sixth of an ampere per sq. km.

L. A. BAUER.

UNIVERSITY OF CINCINNATI.

I AM much obliged to Professor Bauer for his courteous criticism of my theory of terrestrial magnetism, and I am inclined to give great consideration to the opinion of such an authority on the earth's magnetism. I imagined, however, that the electrical currents were largely localized at the region of the astronomical poles of the earth, and I supposed, also, that the earth, as a whole, is para-magnetic.

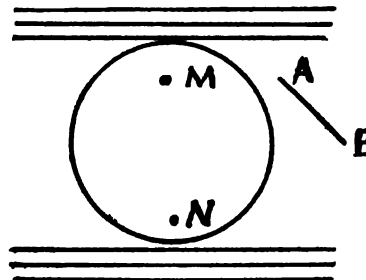


FIG. 1.

According to my theory, poles *M* and *N*, Fig. 1, might, perhaps, be formed in this magnetic matter, which would be competent to produce both inclination and declination of a magnet *A B*. Considerations of the earth's rotation and the temperature of the air currents led me to localize, so to speak, the electrical action at the poles of the earth. It has always seemed to me that Gauss' theory may be considered a mathematical theory, which would be true, considering the limited number of observations he had to work with, whether we suppose the earth's magnetic poles to be formed by currents in the crust of the earth or by rotary phenomena in the medium outside the earth.

JOHN TROWBRIDGE.

NOTES ON INORGANIC CHEMISTRY.

FURTHER studies of hydrozoic acid, HN_3 , are given in the *Journal für praktische Chemie* by Professor Curtius and Dr. Rissom. All of its salts as far as known are anhydrous. Lithium hydrazoate explodes violently on heating, and thallium hydrazoate detonates by percussion; the other hydrazoates of the alkalies and alkaline earths are comparatively stable. When they are heated carefully in small quantities in thin glass tubes they decompose quietly with evolution of nitrogen and the metal is left in a pure condition. This is pointed out as being the easiest method of preparing small quantities of barium, strontium and calcium. In the light of Moissan's recent researches, it would be interesting to know if the residual substance on heating calcium hydrozoate is really metallic calcium, or calcium nitrid, which might readily be formed under these circumstances. The authors further find that a solution of the free hydrozoic acid decomposes to some extent on heating with dilute mineral acids, hence the amount of free acid obtained in this way from the salts is much less than the theoretical.

AN interesting synthesis from acetylene has been accomplished by Berthelot, according to the *Comptes Rendus*. Acetylene is led into fuming sulfuric acid, and the potassium salt of the acid thus formed is fused for a short time at 200°C . On acidification and distillation, phenol is easily recognized. This synthesis is peculiarly interesting from the fact that it is accomplished at such a low temperature.

THE work of Hantzsch and of others on the reactions of inorganic salts in other than aqueous solutions, and especially in solutions of non-electrolytes, is bearing much fruit in enabling the preparation of new inorganic compounds. Hantzsch has just described, in the *Zeitschrift für anorganische Chemie*, the disulfid of silver Ag_2S_2 , corresponding to the recently discovered dioxide, Ag_2O_2 . It is readily precipitated from a solution of silver nitrate in benzonitril, on adding a solution of sulfur in carbon bisulfid. It is a brown amorphous powder, insoluble in ordinary solvents, melts at a fairly high temperature, but rapidly decomposes, and oxidizes with great rapidity in the air when moist or in water. Other solvents, including pyridin, were tried in

its preparation, but benzonitril was the only one found in which the disulfid could be formed.

J. L. H.

ZOOLOGICAL NOTES.

PROFESSORS W. C. HERDMAN and Rupert Boyce have presented to the Royal Society a further study of Oysters and Diseases (published in *Nature*), from which we take the following:

Although we did not find the bacillus typhosus in any oysters obtained from the sea or from the markets, yet in our experimental oysters inoculated with typhoid we were able to recover the organism from the body of the oyster up to the tenth day. We show that the typhoid bacillus does not increase in the body or in the tissues of the oyster, and our figures indicate that the bacilli perish in the intestine.

Our experiments showed that the sea-water was inimical to the growth of the typhoid bacilli. Although their presence was demonstrated in one case on the twenty-first day after addition to the water, still there appeared to be no initial or subsequent multiplication of the bacilli.

In our experiments in washing infected oysters in a stream of clean sea-water the results were definite and uniform; there was a great diminution or total disappearance of the typhoid bacilli in from one to seven days.

The colon group of bacilli is frequently found in shell-fish as sold in towns, and especially in the oyster; but we have no evidence that it occurs in mollusca living in pure sea-water. The natural inference that the presence of the colon bacillus invariably indicates sewage contamination must, however, not be considered established without further investigation.

The colon group may be separated in two divisions: (1) those giving the typical reactions of the colon bacillus, and (2) those giving corresponding negative reactions, and so approaching the typhoid type; but in no case was an organism giving all the reactions of the *B. typhosus* isolated. It ought to be remembered, however, that our samples of oysters, although of various kinds and from different sources, were in no case, so far as we are aware, derived

from a bed known to be contaminated or suspected of typhoid.

We have shown also the frequent occurrence, in various shell-fish from the shops, of anaërobic spore-bearing bacilli giving the characteristics of the *B. enteritidis sporogenes* recently described by Klein.

As the result of our work, we make certain recommendations as to the sanitary regulation and registration of the oyster beds, and as to quarantine for oysters imported from abroad.

CURRENT NOTES ON ANTHROPOLOGY.

ETHNOGRAPHY OF LIBERIA.

IN *L'Anthropologie*, for August, the French Consular Agent at Monrovia, M. Delafosse, gives a sketch of the present ethnography of Liberia. The colored immigrants from the United States, usually with more or less white blood in their veins, have mixed indiscriminately and largely 'de la main gauche' with the native inhabitants. They form a part-colored population, not of a promising character. The indigenous languages belong to four stocks, the Mande, the Kru, the Gola and the Guele, the last mentioned being that of the cannibal tribes on the southeast. The original people of this part of the coast were the Dé, who were related to the Kru tribes and those of the Ivory Coast. The Vei belong to the Mande (or Mandingo) stocks, and are interesting as using a peculiar syllabic alphabet, first observed by Lieutenant Forbes, U. S. N. M. Delafosse says that it was not their invention, as has been stated, but was borrowed by them from some tribe near the source of the Niger.

THE SIGNIFICANCE OF SKULL-MASKS.

THE use of skulls, or imitations of them, as masks, was not uncommon in America, and is quite frequent in Polynesia. Their symbolism and signification are examined by L. Frobenius in the *Internat. Archiv für Ethnographie* (1898, Heft IV.). Rejecting former and incomplete suggestions, he finds this custom arose from that of the adoration of skulls themselves. It is well known that in primitive religion the skulls of men and animals are conspicuous objects of worship, as representing the spirits of the departed. This was connected with the religious

homage to ancestors, to deceased chieftains and to the brute eponymous forefathers of the totem. Sometimes the symbolism of the skull in the mask was reduced merely to the insertion of teeth or some such single feature.

THE SVASTIKA IN AMERICA.

THAT a simple figure, like the Svastika, may arise independently, representing quite different objects, is again illustrated by Mr. Wm. W. Tooker in an article in the *American Antiquarian* for December. Among the marks which were tattooed on the backs of the Virginian Indians as totemic designs we find the Svastika, as Mr. Tooker says, 'in full bloom.' In this instance, from other figures given, the design seems to represent four tomahawks crossed in pairs, the blades in opposite directions. But, as Mr. Tooker remarks, "It is a simple figure which, when compared with others of aboriginal origin, might be evolved from an Indian's brain," without evoking the hypothesis of a foreign immigration. As a 'symbol' it has no constant and universal meaning, and the mystical importance which has been attached to it by some imaginative writers has no foundation in facts.

D. G. BRINTON.

UNIVERSITY OF PENNSYLVANIA.

SCIENTIFIC NOTES AND NEWS.

DR. P. L. SHERMAN, formerly instructor in general chemistry in the University of Michigan, has gone with Professor Worcester to the Philippines as his secretary.

DR. I. BORNMÜLLER has gone to northern Persia on a botanical expedition.

THE Berlin Academy of Sciences has made a grant of 2,400 Marks toward the expenses of a botanical expedition to Java by Dr. Paul Knuth.

THE herbarium of Professor Chodat, of the University of Geneva, has been destroyed by fire.

REPRESENTATIVE SAMUEL J. BARROWS, of Massachusetts, will be appointed Librarian of the National Library. This is regarded as an excellent appointment, that will insure the conduct of the Library without reference to politi-

cal considerations. The position was first offered to Mr. Herbert Putnam, head of the Boston Public Library.

PROFESSOR WILLIAM OSLER, F.R.S., of the Johns Hopkins University, Baltimore, has accepted an invitation to deliver the Cavendish lecture for 1899, before the West London Medico-Chirurgical Society.

THE report is circulated that the remains of Andrée and his companions and the car of the balloon have been found between Kemo and Pit, in the province of Yeniseisk, Siberia.

DR. R. F. CLAUS, the eminent zoologist professor in the University of Vienna, has died at the age of 63 years.

THE London *Times* announces the death of the Rev. Thomas Hincks, F.R.S., at Clifton, on January 26th. He was the son of the late Rev. William Hincks, F.L.S., and was born at Exeter in 1818. He was for many years a Unitarian minister, but had a wide reputation as an authority in several departments of marine zoology, being the author of a history of the British Hydroid Zoophytes, published in 1868, and a history of the British Marine Polyzoa, published in 1889. Both these books are largely the results of his own investigations. He was elected into the Royal Society in 1872, and continued to be an active worker in science until very lately.

WE regret also to record the death of Dr. Hampe, professor of chemistry in the School of Mines at Clausthal, aged 57 years.

THE House Committee on Appropriations has recommended an increase of \$4,200 in the annual appropriation for scientific work of the United States Fish Commission; the entire amount now available for the Department of Scientific Inquiry being \$15,000. This increase is the more gratifying since it is made after an examination of the practical results that have attended the lines of scientific research carried on during the past year.

A BILL has been introduced into the New York Assembly appropriating \$30,000 to continue the promotion of the sugar beet industry, of which \$2,500 is devoted to making experiments by the Commissioner of Agriculture.

THE American Mathematical Society will hold a regular meeting in Room 801 of Fayerweather Hall, Columbia University, on Saturday, February 25th. The two sessions begin at 10:30 a. m. and 2:30 p. m.

AT the annual meeting of the Washington Academy of Sciences recently held, the following officers were elected for the ensuing year: President, Chas. D. Walcott; Vice-Presidents: Anthropological Society, W J McGee; Biological Society, F. V. Coville; Chemical Society, H. N. Stokes; Entomological Society, Dr. H. G. Dyar; Geographic Society, G. K. Gilbert; Historical Society, A. R. Spofford; Medical Society, Dr. S. C. Busey; Philosophical Society, O. H. Tittmann; Secretary, Frank Baker; Treasurer, Bernard R. Green; Managers: Class of 1902: L. O. Howard, J. W. Powell, Carroll D. Wright; Class of 1901: Marcus Baker, Henry S. Pritchett, Geo. M. Sternberg; Class of 1900: F. W. Clarke, C. Hart Merriam, Lester F. Ward. The Academy has arranged for a course of popular lectures on scientific subjects to be given during the months of March and April. A number of demonstrations will also be given on topics of special interest. The first of these was held on the evening of January 31st, and related to Developments in the Art of Recording and Reproducing Sounds, with an exhibition of the new graphophone recently perfected in the Volta Bureau of Mr. Alex. Graham Bell. A welcome donation to the Academy was recently made by Mrs. Gardiner Hubbard, who in view of the life-long interest in science shown by her deceased husband, presented the sum of \$1,000 as a token of her desire to aid in the advancement of science and the union of the scientific interests in Washington. The Academy showed its appreciation of her generosity by at once electing her a patron. Arrangements have been made for the publication of the Proceedings of the Academy. The 'brochure' plan will be adopted, each separate to have its own pagination as well as that of the volume, and to be dated with the actual date of delivery to members. Several papers have already been presented for publication, and it is evident that more funds than are at present available could advantageously be spent for this purpose.

THE Anthropological Society of Washington and the Woman's Anthropological Society have recently united for scientific work, the latter discontinuing separate scientific meetings, and the former modifying its by-laws in such manner as to combine the functions hitherto performed by the two organizations. The union was definitely completed at the annual meeting of the Anthropological Society of Washington on January 17, 1899, at which the modified by-laws were adopted, and at which representatives of both societies were recognized in the ensuing election of officers. The officers for the year are as follows: President, W J McGee; Vice-Presidents—Section A, Somatology, Dr. Frank Baker; Section B, Psychology, Lester F. Ward; Section C, Esthetology, W. H. Holmes; Section D, Technology, Frank Hamilton Cushing; Section E, Sociology, Dr. George M. Kober; Section F, Philology, Major J. W. Powell; Section E, Sophiology, Alice C. Fletcher; General Secretary, Jessie Moore Holton; Treasurer, Perry B. Pierce; Curator, Mariana P. Seaman; Secretary of the Board of Managers, Dr. J. H. McCormick; Councilors, J. Walter Fewkes, Weston Flint, F. W. Hodge, George R. Stetson, Edith C. Westcott, Thomas Wilson; Ex-Officio Members of the Board (as Ex-Presidents), Robert Fletcher, Otis T. Mason.

THE National Geographic Society offers two prizes for the best essays on Norse discoveries in America—a first prize of \$150 and a second prize of \$75. Essays submitted in competition for these prizes should be typewritten in the English language and should not exceed 6,000 words in length. They should be signed by a pseudonym and must be received on December 31, 1899. The judges are: Henry Gannett, Geographer of the U.S. Geological Survey, etc.; Albert Bushnell Hart, professor of history in Harvard University; Anita Newcomb McGee, M. D., Acting Assistant Surgeon, U. S. A.; John Bach McMaster, LL. D., professor of history in the University of Pennsylvania, and Henry S. Pritchett, Superintendent of the U. S. Coast and Geodetic Survey.

A PROVISIONAL committee for the German Empire, in connection with the Thirteenth International Medical Congress, which is to be held

in Paris in 1900, has been formed, with Professor Rudolph Virchow as President.

As we have already announced, the eighth session of the International Geological Congress will be held in Paris from August 16 to 28, 1900, in connection with the great Exposition. The *American Geologist* states that the Committee of Organization, of which M. Albert Gaudry is President, MM. Michel-Lévy and Marcel Bertram, Vice-Presidents, and M. Charles Barrois, General Secretary, has already held several meetings. The Congress will meet in a special pavilion, and the length of its sessions will permit its members to visit the Exposition and the geological museums of Paris. Three general excursions have been arranged in addition to nineteen excursions intended for specialists, in which the number of members who can attend is limited to twenty. A circular describing the plans for these excursions will be sent out in 1899, and a guide book written by the directors of the excursions will be placed on sale at the beginning of 1900.

DR. CHARLES MOHR, of Mobile, Ala., Special Agent of the Forestry Division of the United States Department of Agriculture, has recently presented to the Museum of Pharmacognosy of the University of Michigan some interesting and valuable specimens. They consist of a section of a pine-tree trunk, showing the American method of boxing and bleeding long-leaved pines for turpentine; and of samples of the twenty different turpentine products manufactured in the South. The various stages of the manufacture of turpentine are well illustrated by these specimens.

CONSUL AYERS, of Rosario, under date of December 9, 1898, writes the Department of State that by reason of the continuous onslaught made on the locusts through the efforts of the commissions, aided by a lately developed natural enemy—the Champi beetle—the injury to the crops so far has been very slight. The consul incloses a letter by an American—Maj. O. C. James—describing the beetle, which, it appears, feeds upon the eggs of the locust. The letter reads, in part: "The 'Champi' is the most effective locust-egg destroyer we have in Argentina. He is a dirty blackish beetle, the

larger species being a little more than 1 inch long by half an inch broad, and must be looked for closely where locusts are laying their eggs or his presence may not be discovered. Both the mature insect and its larvæ feed upon the eggs of the acridian in large numbers. These beetles belong to the genus *Trox* of the family *Scarabæidæ*. Ordinarily they feed upon dead animals and animal matter more or less desiccated. How they have developed the habit of feeding upon locusts' eggs is a mystery. Still, it might be imagined that the steps from a carrion-feeding habit could develop that which the insects now possess. In a country where hundreds of dead animals are left scattered over the pampa to decay, these insects have become plentiful. The eggs of the locusts are covered with a frothy exudation that soon becomes strong smelling and attracts the beetles, who devour them." Under date of December 6th, Consul Ruffin, of Asuncion, writes that among the worst pests with which Paraguay is infested are the grasshoppers, which are almost as large as small birds. The name of locust is given them, but they are more like what we call grasshoppers. A government commission to study the question of their extermination has been appointed, and in the last few days a law compelling everybody to help kill the grasshoppers or pay a fine of \$20 paper (equal to about \$2.75 gold) has been passed. The young ones, unable to fly, are killed, the method being to drive them into a long trench and cover them up. The grasshoppers, sometimes for a whole day, obscure the brilliant tropical sun in their flight and make it appear as though the weather were cloudy; they also impede railroad trains.

THE Weather Bureau office in New York City was moved on October 15, 1898, from the Manhattan Building, No. 66 Broadway, to the American Surety Building, No. 100 Broadway, about two blocks farther north. The monthly *Weather Review* gives some details in regard to the old and the new offices. The office quarters in the Manhattan Building consisted of four circular rooms, one immediately above the other, in the tower that rises to an altitude of about 88 feet above the main roof and 355 feet above the curbstone on Broadway. Communication between the four rooms was by means of a central

spiral staircase. The barometer was in the first or lower room. Owing to the presence of the tower and the general configuration of the roof it was necessary to give the anemometer, wind vane and thermometers a much greater elevation than would be afforded by the ordinary supports. The thermometer shelter support consisted of a skeleton framework of iron, high enough to give the thermometers an elevation of 54 feet above the main roof. Access to the shelter was secured by means of a spiral staircase, the iron newel of which extended upward about 34 feet above the top of the framework as a support for the wind vane and anemometer. The last-named instruments were thus placed at an elevation of 326 feet above the curb, but still some distance below the top of the main portion of the tower. This station was thus occupied from March 15, 1895, to October 15, 1898. The office quarters secured in the American Surety Building consist of five rooms *en suite* on the twentieth floor, the next but one to the top of the building. The roof of the building on which the instruments are exposed is almost flat and there are no projecting towers or chimneys on the building itself or surrounding structures to obstruct the free sweep of the wind. The barometer is at the same elevation as in the Manhattan Building. The heights of the instruments above the Pine street curb and the roof are now as follows:

Instruments.	Above curb. Above roof.	
	Feet.	Feet.
Barometer.....	276	.....
Thermometer	313	11.0
Anemometer cups.....	345	43.5
Wind vane.....	322	19.8
Rain gauge.....	305	3.2

THE Boston Society of Natural History, in order to meet a considerable loss of income due to the lower rate of interest now paid upon conservative investments, and also that the efforts of the Society may keep abreast of the new demands arising from the growth of the metropolitan district of Boston, needs additional members. From the statement sent with this appeal we take the following facts regarding the Society: The Boston Society of Natural History was founded April 28, 1830, for 'the en-

couragement and promotion of the science of natural history.' It was incorporated February 25, 1831, and has long been one of the eminent and essentially public institutions of the community. The Society contributes at present to the promotion of science and of public education by the following means: (1) Meetings held on the evenings of the first and third Wednesdays of each month from November to May. These meetings are devoted to the presentation of the results of scientific investigations and to the popular expositions of such studies as are of general public interest. (2) Publication of Memoirs, Proceedings and Occasional Papers, which all record the discoveries of members and others. These publications are widely distributed in all parts of the world, more than four hundred copies being sent to academies, learned societies and other correspondents, as well as to such members of the Society as express a wish to receive them. (3) The Library, which contains upwards of 25,000 volumes and 12,000 pamphlets, includes numerous extensive sets and rare works, many of them not accessible elsewhere in this vicinity. Members are allowed eight volumes at a time for home use, and each volume may be retained a month without renewal. The library privileges are granted without reference to residence. Books are sent by express at the borrower's expense. (4) The Museum contains the collections of the Society and is open to the public on two days of each week. The number of visitors is large on those days. The Museum is open to members on other days. Special efforts have been made to display the fauna, flora and geology of New England. To increase the educational value of the collections, printed guides have been placed on sale. (5) Lectures to teachers and others, which at present are largely maintained by the Trustees of the Lowell Institute.

UNIVERSITY AND EDUCATIONAL NEWS.

It is announced that a donor, whose name is withheld, has endowed in Harvard University a chair of hygiene.

MAXEY HALL, Brown University, has been injured by fire, the damage being estimated at \$25,000.

DR. JAMES MONROE TAYLOR has been elected President of Brown University. Dr. Taylor has been, since 1886, President of Vassar College, where his administration has been very successful.

DR. THOMAS J. SEE, well known for his important researches in astronomy, has been nominated for a professorship of mathematics at the Naval Academy, Annapolis.

MR. W. L. CASCART has been appointed adjunct professor of mechanical engineering in Columbia University. At the same meeting of the Trustees the title of Professor R. S. Woodward was changed from professor of mechanics to professor of mechanics and mathematical physics.

PROFESSOR FRITZ REGEL, of Jena, and Dr. Erich v. Drygalski, of Berlin, have been appointed to professorships of geography in the Universities at Würzburg and Tübingen respectively.

DR. ROBERT OTTO, professor of chemistry in the Institute of Technology at Braunschweig, has retired. Dr. Voswinkel has qualified as docent in chemistry in the Institute of Technology at Berlin.

ACCORDING to the new catalogue of Brown University 925 students are enrolled, an increase of 65 over last year. The increase of the Freshman class, from 168 last year to 216 this, is especially noticeable. There are 99 graduate students.

IN a recent number of the *Harvard Graduates' Magazine*, Professor A. B. Hart publishes a comparative statement of the attendance at the leading American universities. According to his figures the institutions rank in numbers as follows:

Undergraduates in arts and sciences: Harvard, 2,260; Yale, 1,755; Michigan, 1,429; Wisconsin, 1,097; Columbia, 802; Chicago, 783; Pennsylvania, 653; Johns Hopkins, 187.

Graduate students: Chicago, 370; Harvard, 319; Columbia, 313; Yale, 270; Johns Hopkins, 192; Pennsylvania, 151; Wisconsin, 87; Michigan, 73.

The medical department: Pennsylvania, 793; Columbia, 695; Harvard, 646; Michigan, 408; Johns Hopkins, 201; Yale, 112.

The law department: Michigan, 720; Harvard, 543; Columbia, 341; Pennsylvania, 312; Yale, 195.

THE following details are now given in regard to the establishment in Bombay of an Imperial University for India. Mr. Jamsetjee N. Tata offers a property representing a capital of over £200,000 and calculated to yield a yearly income of nearly £10,000 for the establishment of an Imperial University or a Research Institute, in order to supply the want of a higher course of post-graduate instruction in scientific research for the best students of the existing universities. A provisional committee has drafted, for the approval of the government of India, a bill which provides for a scheme of studies with a threefold division: (1) scientific and technological; (2) medical and sanitary, and (3) educational and philosophical. The last of these branches has been included in the scheme in order to give the institution the character of a university. The new institution seeks to have the power of granting degrees and diplomas, and as it proposes to offer a strictly post-graduate course of studies it will not in any way interfere with the working of any of the existing universities. The scheme of the provisional committee involves an expenditure larger than is provided for by Mr. Tata's generous offer. A grant in aid, therefore, will be asked for from the government of India. The support of native princes, of local governments and of the public generally will be sought. It is estimated that the initial expenditure required will amount to over £100,000 and the annual charge to about £20,000. On this basis, therefore, it is proposed to establish the several departments by degrees and to found subsequently special chairs through public and private munificence.

THE following statements from a circular of the German Colonial School at Witzerhausen should be of special interest to Americans at the present time, as showing what Germany is doing to promote the education of men who intend to engage in industrial enterprises in her colonies. Similar institutions are maintained in Belgium and Holland. The purpose of this school, we quote from an announcement sent by the Division of Publications of the Department of Agriculture, is to educate young men to become practical superintendents of estates and plantations, planters, agriculturists, stock raisers and merchants for the German colonial possessions. The

course of study, which is completed in two years, comprises the following studies: Plant culture in general, including the study of soils, climate and fertilizers, farm management, bookkeeping, mechanics, engineering (bridge and road building, drainage, irrigation); special plant culture, animal husbandry and dairying; culture, use and value of tropical plants; establishment of plantations; gardening; fruit culture; vegetable culture; viticulture; forestry; geology, with special reference to tropical mining; botany (physiology, anatomy, systematic and geographical); chemistry, with laboratory practice; surveying and drafting; hygiene for tropical countries; veterinary science; colonial history and geography; a study of the people; the history of education, religion and missionary work; colonial government, and commercial laws and relations; languages; trades (carpenters, masons, blacksmiths, harness-makers, bakers, butchers, etc.); practical work in field, garden, vineyard, forest, dairy, etc.; athletics (sports) of all kinds.

PROFESSOR W. A. HERDMAN, F.R.S., remarks in the twelfth annual report of the Liverpool Marine Biological Committee, says *Nature*, that there are two practices in American universities which excite the envy of professors in England. One is the 'sabbatical year'—the one year in every seven given for purposes of travel, study and investigation. The other is the frequent endowment of an expedition—or equipment of an exploring party—by an individual man or woman who is interested in the subject and can give a special fund for such a purpose. Columbia University, in New York; the Johns Hopkins University, in Baltimore; Yale University, in New Haven, and Harvard, at Cambridge, have all been benefited immensely in the past by such exploring expeditions. Nearly every year of late has seen one or more of such, due to private generosity, in the field; and the work they have done has both added to general scientific knowledge, and has also enriched with collections the laboratories and museums of the college to which the expedition belonged.

Erratum: Vol. IX., p. 174. Line 12 from bottom of second column, for *Australia* read *Austria*.

SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; J. LE CONTE, Geology; W. M. DAVIS, Physiography; O. C. MARSH, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; HENRY F. OSBORN, General Biology; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; J. McKEEN CATTELL, Psychology; DANIEL G. BRINTON, J. W. POWELL, Anthropology.

FRIDAY, FEBRUARY 24, 1899.

CONTENTS:

<i>The Recently Discovered Gases and their Relation to the Periodic Law</i> : PROFESSOR WILLIAM RAMSAY.....	273
<i>A Case of Convergence</i> : PROFESSOR CARL H. EIGENMANN.....	280
<i>Reproductive or Genetic Selection</i> : PROFESSOR KARL PEARSON.....	283
<i>The New York Meeting of the American Physiological Society</i> : PROFESSOR FREDERIC S. LEE.....	286
<i>Scientific Books:—</i>	
<i>Thomson on the Discharge of Electricity through Gases</i> : PROFESSOR ERNEST MERRITT. <i>Schäfer's Text-book of Physiology</i> : PROFESSOR GRAHAM LUSK. <i>Scientific Year-books. General. Books Received</i>	289
<i>Scientific Journals and Articles</i>	293
<i>Societies and Academies:—</i>	
<i>Washington Botanical Club</i> : DR. CHARLES LOUIS POLLARD. <i>Torrey Botanical Club</i> : E. S. BURGESS. <i>Philosophical Society of Washington</i> : E. D. PRESTON. <i>Alabama Industrial and Scientific Society</i> : PROFESSOR EUGENE A. SMITH.....	294
<i>Discussion and Correspondence:—</i>	
<i>Etherion</i> : PROFESSOR W. S. FRANKLIN.....	297
<i>Notes on Inorganic Chemistry</i> : J. L. H.....	297
<i>Current Notes on Meteorology:—</i>	
<i>Waterspouts off the Coast of New South Wales</i> : <i>Annual Report of the Chief of the Weather Bureau</i> : <i>Meteorological Chart of the Great Lakes</i> : <i>Notes</i> : R. DE C. WARD.....	298
<i>Current Notes on Anthropology:—</i>	
<i>Megalithic Monuments: The Meaning of Primitive Ornament</i> ; <i>Genealogy as a Branch of Anthropology</i> : PROFESSOR D. G. BRINTON.....	299
<i>Scientific Notes and News</i>	300
<i>University and Educational News</i>	304

MSB. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

THE RECENTLY DISCOVERED GASES AND THEIR RELATION TO THE PERIODIC LAW.*

GENTLEMEN: It is well known to you all how the remarkable observation of Lord Rayleigh that nitrogen from the atmosphere possesses a greater density than that prepared from ammonia or nitrates led to the discovery of argon, a new constituent of the air. I need not say that had it not been for this observation the investigations of which I shall speak this evening would never have been carried out, at least not by me. You also, doubtless, will remember that the search for some compound of argon was rewarded, not by the attainment of the quest, but by the discovery, in clèvite and other rare uranium minerals, of helium, an element whose existence in the chromosphere of the sun had already been suspected. And, further, I hardly need to recall to your minds that the density of helium is in round numbers 2, and that of argon 20, and that the ratio of specific heats of both these gases, unlike that of most others, is 1.66.

From these figures it follows that the atomic weight of helium is 4 and that of argon 40. It is true that in many quarters this conclusion is not admitted, but I have always thought it better to recognize the

*Address delivered by Professor William Ramsay before the Deutschen chemischen Gesellschaft, December 19, 1898. Translated by J. L. H.

validity of the theory of gases and accept the logical deductions than to deny the truth of the present theories. The only reason for not admitting the correctness of these atomic weights is that that of argon is greater than that of potassium, but this is no severer attack upon the validity of the periodic law than the accepted position of iodine after, instead of before, tellurium. As a matter of fact, all the more recent determinations of the atomic weight of tellurium give the figure 127.6, while that of iodine remains unchanged at 127.

Since these new elements form no compounds, it is not possible to decide the question by purely chemical methods. Were it only possible for us to prepare a single volatile compound of helium or of argon our problem would be solved. In spite of many attempts, I have not been able to confirm Berthelot's results with benzene or carbon bisulfide. I have, however, offered to place a liter of argon at the disposal of my distinguished colleague, that he may repeat his experiments on a larger scale. No one can doubt that it is exceedingly desirable that the question of these atomic weights should be finally decided and that by chemical methods.

In order that the subject may not depend wholly on physical theories, I have considered it from another standpoint. If we assume, as from countless chemical facts we are fully justified in doing, that the periodic law is true, then, giving helium the atomic weight 2 and argon 20, there is no possible place for an element of their mean atomic weight; for, unless we absolutely overturn the accepted views, there is no vacancy in the table for such an element. This appears from the following portion of the table:

H=1 He=2(?) Li=7 G=9.2 B=11 C=12
N=14 O=16 F=19 A=20(?)

It is true there is space enough between He=2 and Li=7, but it is highly im-

probable that an element belonging to the argon-series could have so low an atomic weight. The difference between adjacent members of the same group of elements is generally from 16 to 18 units, but here such a difference is wholly excluded. If, on the other hand, we assume He=4 and A=40, it would be, in my opinion, by no means improbable that such an element could exist whose atomic weight would be somewhere about 16 units greater than that of helium, and consequently 20 units less than that of argon. The discovery of such an element would be, therefore, not only a proof of the correctness of 40 as the atomic weight of argon, but also a confirmation of the present views regarding the significance of the specific heats of gases for their molecular weight.

A glance at the periodic table will make these considerations clear, for in the latter case we have the following series:

Li=7 G=9.2 B=11 C=12 N=14
Na=23 Mg=24.3 Al=27 Si=28 P=31
He=4
O=16 F=19 (?)=20
S=32 Cl=35.5 A=40

Shortly after the discovery of helium I began the search for this suspected element of atomic weight of about 20, at first in connection with Dr. Collie, my former assistant, and later with my present assistant, Dr. Travers.

At first it appeared not improbable that this element might be found in those uranium minerals from which helium had been obtained. We did not, however, confine ourselves to these minerals, but tested all available minerals either by heating in a vacuum or by fusion with sodium bisulfate. In many of these minerals helium was found; in many, on the other hand, only traces of hydrocarbons and hydrogen. One mineral only, malakon, gave sufficient argon to be recognizable by the spectro-scope; the others which contained helium

gave off generally also a trace of argon, as was later shown by our diffusion experiments. Naturally, it was impossible to be certain that the few cubic centimeters of gas which we collected from these minerals contained no new gas, but we failed to detect the presence of any new lines with the spectroscope.

You will, undoubtedly, recall that, soon after the discovery of helium, doubts were expressed in many quarters as to whether the gas was really uniform or a mixture. In order to dispel these doubts and also to search for the missing gas, Dr. Collie and I carried out a long series of diffusion experiments. Through these we reached the conclusion that it was, in fact, possible to separate helium into two constituents, one of which possessed a somewhat higher density than the other. Later experiments, however, in conjunction with Dr. Travers, showed that this conclusion was erroneous. In this second series much larger quantities of helium were at our disposal, and, to our disappointment, we found that the heavier fractions of our gas owed their greater density to the presence of a trace of argon. Here, again, we were unable to find any new line in the spectrum, and thus far our search was fruitless.

We next directed our attention to meteorites and to mineral waters. Only one out of seven meteorites examined by Dr. Travers and myself showed the presence of helium and with it a trace of argon; the others gave only hydrogen and hydrocarbons, which were also present in the gases from the meteorite which contained helium and argon. Here, again, our search was in vain. The mineral water from Bath has been investigated by Lord Rayleigh; in the waters from Cantarets, in the Pyrenees, Dr. Schlösing has found both argon and helium. Dr. Travers and I examined these gases for new lines, but, as before, none were found.

Our patience was now well-nigh ex-

hausted. There seemed, however, to be a single ray of hope left, in an observation which had been made by Dr. Collie and myself. You will recall that the atomic weight of argon was apparently too high; at all events, it would be more in harmony with the periodic law if the density of argon were 19 instead of 20, and hence its atomic weight 38 instead of 40. Hence, after some fruitless attempts to separate argon into more than one constituent by means of solution in water, we undertook a systematic diffusion of argon. We did not, however, carry this procedure very far, for, at that time, we believed that helium was a more probable source of the desired gas; nevertheless, we found a slight difference in density between the gas which diffused first and that which remained undiffused. We, therefore, decided to prepare a large quantity of argon, and, after liquefying it, to investigate carefully the different fractions on distillation.

Such an operation demands much time. In the first place, the necessary apparatus is not to be found in any ordinary chemical laboratory; the preparation cannot be carried out in glass tubes in an ordinary furnace, but requires iron tubes of large size and an especial furnace; in the second place, the operation must be repeated several times, for it is not convenient to work with an excessively large quantity of magnesium. As before, we removed the oxygen from the air by means of copper at a red heat; the atmospheric nitrogen remaining was collected in a large gasometer holding about 200 liters; after drying over concentrated sulfuric acid and phosphorus pentoxid, the gas was passed through an iron tube of 5 cm. diameter, filled with magnesium filings; the gas was then passed through a second copper oxid tube to remove the hydrogen; it then entered a galvanized-iron gasometer, which was constructed like an ordinary illuminating-gas gasometer, in or-

der that the argon should come in contact with as little water as possible, since argon is quite appreciably soluble in water, and, had the ordinary form of gasometer been used, much would have been lost in this way. Again, the gas had to be led over hot magnesium to reduce still further the quantity of nitrogen; and at last it was circulated between the gasometers, passing on its way through a mixture of thoroughly heated lime and magnesia at a red heat. This is a means of absorption, recommended by Maquenne, to remove the last of nitrogen. Since, however, it is not possible to dry the lime absolutely, hydrogen is taken up by the gas, and this must again be removed by copper oxid, in order that all the hydrogen may be burned, after which the water must again be removed by drying tubes.

These operations required several months and were chiefly directed by Dr. Travers.

Meanwhile, it seemed to be worth while to make an examination as to whether the desired gas might possibly form compounds and be united with the magnesium, by which the nitrogen had been removed. Miss Emily Aston assisted me to settle this question.

Some 700 grams of the magnesium nitrid were, for this purpose, treated with water in a large exhausted flask, in such a manner that the evolved ammonia was absorbed in dilute sulfuric acid which had been thoroughly boiled; all the other gases were collected by a Töpler pump. The total volume of this gas was hardly 50 ccm.; it proved to be chiefly hydrogen, with a trace of hydrocarbons, arising from the small quantity of metallic magnesium present in the magnesium nitrid. After the hydrogen had been removed by explosion, an excess of oxygen was passed into the tube and the nitrogen removed in the usual manner by sparking over alkali. The presence of nitrogen here was undoubt-

edly due to the impossibility of perfectly exhausting all the air from so large a flask; the volume of nitrogen was about 10 ccm. There now remained but a minute bubble of gas, and on transferring this to a vacuum tube at very low pressure the spectrum of argon appeared. There was here, therefore, no trace of a new gas to be found.

It was not deemed worth while to investigate the ammonia, since I had already prepared nitrogen out of this and Lord Rayleigh had determined its density; he found this to be exactly the same as the density of nitrogen from different chemical sources. It remained, however, possible that the sought-for gas could combine with hydrogen, and that such a compound might possess an acid character; in this case it might have entered into combination with the magnesium. On account of the possibility that such a compound might be soluble, the magnesia was extracted with water, the solution evaporated and treated with sulfuric acid in a vacuum. A gas was evolved, but it proved to be exclusively carbon dioxid. We should have carried the treatment of the magnesium further had not the argon at last become sufficiently pure to subject it to the refrigerating action of liquid air; and it seemed to me there was more hope of finding the new substance in the argon from the atmosphere than in this residue of magnesia, which it would require much time and labor to work up.

Dr. Hampson, the inventor of a very simple and practical machine for the preparation of liquid air, which is based upon the same principle as that of Herr Linde, was so kind as to place large quantities of liquid air at my disposal. In order to become acquainted with the art of working with so unusual a material, I asked Dr. Hampson for a liter; with this Dr. Travers and I practiced and made different little experiments to prepare ourselves for the great experiment of liquefying argon.

It seemed to me a pity to boil away all the air without collecting the last residue; for, though it seemed improbable that the looked-for element could be here, yet it was, indeed, possible that a heavier gas might accompany the argon. This suspicion was confirmed. The residue from the liquid air consisted chiefly of oxygen and argon, and, after removing the oxygen and nitrogen, beside the spectrum of argon were two brilliant lines, one in the yellow, which was not identical with D_2 of helium, and one in the green. This gas was decidedly heavier than argon; its density was 22.5 instead of the 20 of argon. We had, therefore, discovered a new body, which was an element, for the ratio between the specific heats was 1.66. To this element we gave the name 'krypton.' Up to this time we have not followed further the study of this element; we have, however, collected and preserved many residues which are rich in krypton. It was, however, our first intention to examine the lightest part of the argon. In many, however, we remarked, in passing, that the wave-length of the green line of krypton is exceedingly close to that of the northern lights, being 5,570, while the latter is 5,571. Our whole supply of argon was now liquefied in the following manner. The gasometer containing the argon was connected with a series of tubes in which the gas passed over respectively hot copper oxid, concentrated sulphuric acid and phosphorus pentoxid; it then passed by a two-way cock into a small flask, holding about 30 cubic centimeters, which was enclosed in a Dewar tube. By means of the other opening of the cock, the flask was connected with a mercury gasometer. By means of a U-shaped capillary and mercury trough, it was also possible, through a three-way cock, to collect the gas at will in glass tubes. About 50 cubic centimeters of liquid air were poured into the double-walled tube, and, by means of a Fleuss air pump kept constantly

in action, the liquid air boiled at 10 to 15 millimeters pressure. The argon liquefied rapidly as soon as subjected to this low temperature, and in the course of half an hour it was completely condensed. Altogether there were about 25 cubic centimeters of a clear, limpid, colorless liquid, in which floated white flakes of a solid substance. By stopping the pump, the pressure over the liquid air was now increased, and the argon boiled quietly, the first portions of the gas being collected in the mercury gasometer. Changing now the three-way cock, the largest portion of the argon passed back into the iron gasometer; after nearly all the liquid had boiled away and only the solid substance was left in the flask, the last portions of the gas were collected separately. The solid substance remained persistently in the flask; it was slowly volatilized by means of a Töpler pump, which stood in connection with the apparatus.

We first directed our attention to the lighter fractions, for these had for us the greatest interest. The density of this gas was found to be 14.67; the ratio between the specific heats was as usual 1.66, and the spectrum showed, beside the well-known groupings of argon, a large number of red, orange and yellow lines of varying intensity. Evidently, we had before us a new element, which was contaminated with argon.

This gas was then liquefied in a similar apparatus to that first used, but constructed on a smaller scale; a portion, however, remained uncondensed. Even by raising the reservoir of the mercury gasometer until an overpressure of an atmosphere was reached, it was impossible to convert all the gas into a liquid, although the temperature of the boiling air was reduced as low as possible by rapid pumping. By repeated raising and lowering of the reservoir, we finally passed all the gas through the cooled space, in order to free it, as far as possible, from argon. The uncondensable gas was

collected by itself, and the remainder was evaporated into another gasometer.

You can well imagine how eager we were to know what the density of this purified gas would prove to be. It was immediately weighed. Our satisfaction can well be realized when we found that its density was 9.76. Since, however, its spectrum at low pressure still showed argon lines, though weak, we were compelled to admit that this number was certainly too high. It was impossible that this gas should not contain argon, since at the temperature used argon possessed a measurable vapor pressure.

We have, therefore, estimated that the density of the pure gas is 9.65. Here our work for the time was ended by the beginning of the summer holidays.

On our return we resumed the study of this gas, which we will hereafter designate by its name of 'neon.' Its spectrum was photographed by Mr. Baly, one of my assistants, by means of a spectrometer which we had constructed during the vacation. To our astonishment, the lines of helium were easily recognized. A comparison photograph showed this beyond all question. Hence the density of the gas was in all probability too low, owing to the presence of the helium. Since now the temperature used was insufficient to liquefy the neon, and since the argon had been removed as far as possible, we had to face the problem of how one could free neon from its accompanying impurities. A means was found in its solubility. It is well known that the solubility of those gases which do not react chemically with the solvent follows in general the same order as their condensibility. According to this helium should have a lesser solubility than neon, and neon than argon. The solubility of these gases in water is, however, too slight to be available for their separation. We have, therefore, used liquid oxygen as a solvent. This mixes with all three gases and boils at a temperature not

far from the boiling point of argon. We, therefore, mixed the gas with sufficient oxygen to be almost wholly condensed at the temperature attained by boiling air at the lowest possible pressure. The uncondensed portion, about one fifth of the whole, was separated and collected as that richest in helium; the middle portion we considered as purified neon, while the remainder consisted of a mixture of argon and neon; naturally, all these portions contained oxygen in larger or smaller quantities.

After the removal of the oxygen, which was accomplished by passage over hot copper filings, we determined the density and refractivity of the middle portion. The density in two determinations was 10.04 and 10.19; the second figure was obtained after passing the electric spark through the gas mixed with oxygen in the presence of caustic potash and subsequent removal of the oxygen by phosphorus. The entire quantity weighed was only 30 cubic centimeters at a pressure of 250 millimeters. The weight was 0.0095 gram. I mention these figures in order to show with what an exceedingly small quantity of gas it is possible to carry out a very satisfactory density determination.

The refractivity of this portion with reference to the air as unity was 0.338. This portion still showed the spectra of argon and helium, and was, therefore, submitted to a second purification, in which the heavier part was more completely removed than the lighter. Even this purification, however, did not remove all the argon, but its quantity was decidedly diminished. The density was somewhat diminished, and helium was stronger in the spectrum. The entire amount of neon had become, by these operations, so divided up that it was not possible to carry out a further purification without preparing a greater quantity of crude neon. On this Dr. Travers and I are at present engaged.

In the meantime Mr. Baly has made exact measurements of the lines of the neon spectrum, at the same time eliminating all the lines which belong to argon and to helium by superposed plates. The values were compared with iron lines photographed upon the same plate, and the measurements were carried out by means of different pairs of these known lines. The most important lines are the following :

MOST IMPORTANT LINES OF THE NEW SPECTRUM.

Red.	Red.	Red.	Yellow (D _r).	Blue
6402	6267	6096	5853	4716*
6383	6218	6074	Green 5401	4722
6335	6164	6030	5341	4710
	6143		5331	4709
				4704

Up to the present we have had little time to study thoroughly the other companion of argon in the atmosphere. Dr. Travers and I have, however, worked upon it. The heavier fraction of the air contains three gases, one of which appears very perplexing. We have named it 'metargon.' This gas remains, mixed with excess of argon, after the evaporation of liquid air or argon. Up to this time we have not succeeded in obtaining it in a condition free from argon. Its peculiarity is that when it is mixed with oxygen and subjected to the influence of the electric spark in presence of caustic potash it shows constantly the 'Swan-spectrum' as of carbon monoxid. We have treated a mixture of carbon monoxid and argon in a similar way, and, after fifteen minutes' sparking, all the carbon had disappeared; in a Plücker tube no trace of the carbon spectrum could be recognized. I will, however, not yet venture to express an opinion as to the nature of this gas. It needs further investigation, and for this at present we have no time.

As regards krypton, which is distinguished by three brilliant lines, one in red,

* The third figure in this number is probably a misprint (Tr.).

one in yellow and one in green, we are in much the same position. We have collected a considerable quantity of the impure gas, which shows the spectrum finely, although that of argon is also present. We hope that we shall soon be able to pursue this portion of our work further. We can merely note here that the specific gravity of the gas which shows this spectrum in such a marked way is not far different from that of argon.

The heaviest of these gases we have weighed, although in impure condition. Its density is 32.5. I need not call your attention to the fact that there is space for an element of the helium group between bromin and rubidium. Such an element should have an atomic weight of 81-83, which corresponds to a density of 40.5-41.5, under the very probable supposition that, like the other gases of this group, it is monatomic. The spectrum of this gas, which we have named 'xenon'—the stranger—has many lines; none of these are of marked intensity, and in this respect the spectrum resembles somewhat that of argon. It is also analogous to argon in another particular, that the spectrum undergoes a remarkable change when a Leyden jar is put into the circuit. As with argon, many new, blue and green lines appear, while other lines, mostly in the red, either disappear or lose much of their intensity. Further than this we have not proceeded in studying xenon; for our attention has been given chiefly to neon, as well as to a problem regarding argon.

We have repeatedly met the question: "Are the properties of argon not appreciably changed by the presence of this new gas?" In order to settle this question we have fractioned 25 cubic centimeters of liquid argon several times and have collected separately about 200 cubic centimeters of the lightest and as much of the heaviest fraction. This operation was repeated three

times. By this means we hoped to have removed the greatest part of the neon, krypton, metargon and xenon. Then we liquefied the argon a fourth time, and as it boiled away collected six samples, each after one-fifth of the whole quantity had evaporated. These samples were carefully purified and weighed. The density referred to $0 = 16$ and the refractivity to air $= 1$ are as follows :

	Density.	Refractivity.
First fraction	19.65	0.962
Second "	19.95	0.969
Third "	19.95	.....
Fourth "	19.91*	.....
Fifth "	19.97	0.968
Sixth "	19.95	0.966

The first fraction possesses, as appears from the table, a lower density and also a lower refractivity. The other fractions vary very little from each other. Since these determinations were made by using only 30 cubic centimeters, we have weighed 160 cubic centimeters of the fifth and sixth fractions. The first determined density of the fifth fraction was 19.935, but at a pressure of 5 millimeters the spectrum of nitrogen was easily recognizable in a Plücker tube. After the gas had been again purified by sparking, until all the nitrogen had been removed, the density was 19.957. In two experiments the fourth fraction of gas gave 19.952 and 19.961. We must then accept the true density of argon as not far from 19.96. Independently Lord Rayleigh and I found the density of argon to be 19.94 ; so it is clear that the impurities of neon and the heavier gases have little influence. The somewhat greater density of pure argon arises from the fact that the neon, which is the chief impurity present, has been removed ; the influence of the other gases cannot be recognized, owing to the insignificant quantities present. In fact, in 15 liters of argon we found no appreciable trace of xenon ; it can

* Contained nitrogen.

be prepared only out of large quantities of liquid air.

I must take this opportunity of thanking you most sincerely for the honor you have done me in inviting me to deliver this address. It has been said by some scientist that the greatest joy of life lies in discovering something which is new. There is, however, another joy almost equally great, that of making known the results of an investigation to one's fellow scientists. This joy, my friends, you have given me to an extreme degree, and for this I express to you my warmest thanks.

A CASE OF CONVERGENCE.*

IN 1859 Girard (Proc. Acad. Nat. Sc. Phila., p. 62) described a small blind fish, *Typhlichthys subterraneus*, from Bowling Green, Ky. This species has since been found to be abundant in the subterranean waters east of the Mississippi and south of the Ohio.

In 1889 Garman (Bull. Mus. Comp. Zool. XVII., No. 6) gave an account of a blind fish from some caves in Missouri. Mr. Garman says : " Compared with specimens from Kentucky and Tennessee, they agree so exactly as to raise the question whether the species was not originated in one of the localities and thence distributed to the others. * * * There is no doubt that the representatives of *Typhlichthys subterraneus* in the various caves were derived from a single common ancestral species. The doubts concern only the probability of the existence of three or more lines of development in as many different locations, starting from the same species and leading to such practical identity of result."

Able arguing the case from the data on hand Garman came to the conclusion " that these blind fishes originated in a particular locality, and have been and are being dis-

* Contributions from the Zoological Department of the Indiana University, No. 27.

tributed among the caves throughout the valley" (of the Mississippi).

Two of the specimens from Missouri served Kohl (Rudimentäre Wirbelthieraugen, 1892) for his account of the eyes of North American blind fishes. At my request Mr. Garman sent me two of the Missouri specimens. He urged me at the same time to make a more extensive comparison between them and the Mammoth cave specimens. A comparison of the eyes of specimens from the two localities not only proved that they represent distinct species, but that they are of separate origin. An announcement of the species without further description was published (Proc. Ind. Acad. Sci. for 1897, p. 231, 1898). The species was "named *rosæ* for the rediscoverer of the California *Typhlogobius*, a pioneer in the study of Biology among women,

eight specimens. I have since received an additional number from a correspondent. From information gathered it would seem that this species (or similar ones) has a wide distribution in the subterranean waters of the southern half of Missouri and northern Arkansas, probably also the eastern part of Kansas.

On the surface the specimens very closely resemble *Typhlichthys subterraneus* from Mammoth cave, differing slightly in the proportion and in the pectoral and caudal fins. These fins are longer in *rosæ*. It is, however, quite evident from a study of their eyes that we have to deal here with a case of convergence of two very distinct forms. They have converged because of the similarity of their environment and especially owing to the absence of those elements in their environment that lead to external

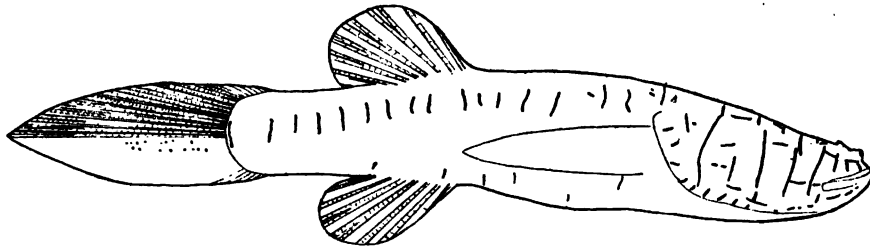


FIG. 1. Side view of *Troglodytes* showing the extent and distribution of the tactile organs.

Mrs. Rosa Smith Eigenmann." In the spring of 1897 I visited various caves in Missouri to secure additional material of what was recognized as in many ways the most interesting member of the North American fauna. No specimens were secured, but a liberal number of bottles of alcohol and formalin were scattered over the country. During the fall of 1898, through a grant from the Elizabeth Thompson Science Fund and through the courtesy of the officers of the Monon, the L. E. and St. L. and the Frisco R. R. lines I was enabled to visit the cave region of Missouri again. This time I visited nine caves and secured

protective adaptations. The details of the structure of the eyes of all the members of the Amblyopsidæ will be published shortly, and I need call attention here only to the structures that warrant the conclusion that the cis- and trans-Mississippi forms of blind fishes without ventral fins are of distinct origin. The blind fish *Amblyopsis* may be left out of consideration, since it is the only member of the family that possesses ventral fins. Otherwise, it would be difficult to distinguish specimens of similar size of this species from either *subterraneus* or *rosæ*.

The eye of *T. subterraneus* is surrounded by a very thin layer of tissue representing

the sclera and choroid. The two layers are not separable. In this respect it approaches the condition in the epigeal-eyed member of the family, *Chologaster*. For other reasons that need not be given here it is quite certain that *Typhlichthys* is the

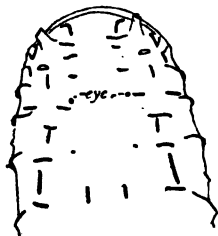


FIG. 2.

FIG. 2. Dorsal view of the head, with distribution of tactile organs and location of eye.

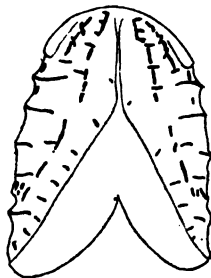


FIG. 3.

FIG. 3. Ventral view of the head.

descendant of [a *Chologaster*. The intensity of coloration and the structure of the eye are the chief points of difference. The eye of *rosæ* is but about 1-3 the diameter of that of *subterraneus*, measuring .06 mm. or thereabout. It is the most degenerate, as distinguished from undeveloped, vertebrate eye. The point of importance in the present instance is the presence of comparatively enormous scleral cartilages.* These have not degenerated in proportion to the degeneration of the eye and in some cases are several times as long as the eye, projecting far beyond it or are puckered to make their disproportionate size fit the vanishing eye. This species is unquestionably descended from a species with well-developed scleral cartilages, for it is not conceivable that the sclera as found in *Chologaster* could, by any freak or chance, give rise during degeneration to scleral cartilages, and if it did they would not develop several sizes

* Kohl mistook the nature of these structures, as he did of every other connected with these eyes, except the lens and ganglionic cells.

too large for the eye. At present no known epigeal species of the Amblyopsidæ possesses scleral cartilages. The ancestry of *rosæ* is hence unknown. *Amblyopsis* possesses scleral cartilages and the eye of *rosæ* passed through a condition similar to that possessed by *Amblyopsis*, but the latter species has ventral fins and is hence ruled out as a possible ancestor of *rosæ*. The epigeal ancestry of *Amblyopsis* is also unknown. The ancestry of *Typhlichthys* being quite distinct from that of *rosæ*, the latter species may be referred to a new generic name *Troglichthys*.

Judging from the degree of degeneration of the eye *Troglichthys* has lived in caves and done without the use of its eyes longer than any other known vertebrate. (*Ipnope* being a deep-sea form is not considered.) More than this, *rosæ* is probably the oldest resident in the region it inhabits.

Since the specimens kindly sent by Mr. Garman, in the course of examination have been reduced to sections, the specimens now in my possession, together with a few sent to the British Museum, all having come from the same cave, may be considered typical.

In addition to the acknowledgments made before I wish also to thank the officers of the Louisville and Nashville R. R. for transportation to Mammoth Cave. I must especially express my appreciation of the assistance rendered me by Mr. William McDoel, General Manager of the Monon, in enabling me to make explorations in the numerous caves of the Lost River region along his line and to visit caves at greater distances. Mr. H. C. Ganter, the manager of the Mammoth Cave Hotel, not only granted me leave to collect in the cave, but did everything possible to make my trip to this cave successful.

CARL H. EIGENMANN.

UNIVERSITY OF INDIANA.

REPRODUCTIVE OR GENETIC SELECTION.*

1. THE object of this memoir is twofold: first, to develop the theory of reproductive or genetic selection† on the assumption that fertility and fecundity may be heritable characters; and, secondly, to demonstrate from two concrete examples that fertility and fecundity actually are inherited.

The problem of whether fertility is or is not inherited is one of very far reaching consequences. It stands on an entirely different footing to the question of inheritance of other characters. That any other organ or character is inherited, provided that inheritance is not stronger for one value of the organ or character than another, is perfectly consistent with the organic stability of a community of individuals. That fertility should be inherited is not consistent with the stability of such a community, unless there is a differential death-rate, more intense for the offspring of the fertile, *i. e.*, unless natural selection or other factor of evolution holds reproductive selection in check. The inheritance of fertility and the correlation of fertility with other characters are principles momentous in their results for our conceptions of evolution; they mark a continual tendency in a race to progress in a definite direction, unless equilibrium be maintained by any other equi-

pollent factors, exhibited in the form of a differential death-rate on the most fertile. Such a differential death-rate probably exists in wild life, at any rate until the environment changes and the equilibrium between natural and reproductive selection is upset. How far it exists in civilized communities of mankind is another and more difficult problem, which I have partially dealt with elsewhere.* At any rate it becomes necessary for the biologist either to affirm or deny the two principles stated above. If he affirms them, then he must look upon all races as tending to progress in definite directions—not necessarily one, but possibly several different directions, according to the characters with which fertility may be correlated—the moment natural selection is suspended; the organism carries in itself, in virtue of the laws of inheritance and the correlation of its characters, a tendency to progressive change. If on the other hand, the biologist denies these principles, then he must be prepared to meet the weight of evidence in favor of the inheritance of fertility and fecundity contained in Parts II and III of the present memoir.

2. The theory discussed in Part I opens with the proof that if fertility be a function of any physical characters which are themselves inherited according to the law of ancestral heredity, then it must itself be inherited according to that law. As fertility would certainly appear to be associated with physique, we have thus an *a priori* argument in favor of its inheritance.

3. In the next place the influence of 'record' making on apparent fertility is considered. The mother with more offspring has a greater chance than one with fewer of getting into the record which extends over several generations, and, further, if every possible entry be taken from the

* *Mathematical Contributions to the Theory of Evolution.* Part I, Theoretical: By Karl Pearson. Part II, On the Inheritance of Fertility in Man: By Karl Pearson and Alice Lee. Part III, On the Inheritance of Fecundity in Thoroughbred Race-horses: By Karl Pearson, with the assistance of Lealie Bramley-Moore. Abstracts read before the Royal Society, December 8, 1898.

† I have retained the term 'reproductive' selection here, although objection has been raised to it, because it has been used in the earlier memoirs of this series. Mr. Galton has kindly provided me with 'genetic' and 'preferential' selection. The term is used to describe the selection of predominant types owing to the different grades of reproductivity being inherited, and without the influence of a differential death-rate.

* *Essay on Reproductive Selection in 'The Chances of Death and other Studies in Evolution,'* Vol. 1, p. 63.

record, she is again weighted with her fertility. Thus a record is not a true account of the fertility of successive generations. The fertility of mothers is always found to be more and their variability less than the fertility and variability of daughters. Accordingly from the apparent fertility and variability of the record the actual values in each generation must be deduced. The difficulties and the theory of this investigation are developed at some length, and methods determined by which it can be ascertained whether a secular change in fertility is actually taking place. The results obtained are extended to fecundity.

4. In the case of thoroughbred horses their number is so few and in-breeding so great, owing to the fashion in sires and stocks, that we have to deal with a large array of offspring of the same sire. It is easy accordingly to obtain 50,000 to 150,000 pairs of a given relationship, *e. g.*, half-sisters, and we rapidly get numbers too large for forming correlation tables in the usual manner. Accordingly methods are developed for finding correlation coefficients from the means of 'arrays.' These methods are of considerable importance, for they enable us to ascertain the correlation between a latent character in one sex and a patent character in another, or between characters latent in two individuals. Thus it is shown that the correlation between the brood-mare's fecundity latent in two related stallions can be deduced from the correlation between the mean fecundities of their two arrays of daughters. In this way a numerical estimate can be formed of the inheritance of latent characters.

5. The brood-mare is for many causes, detailed at length in the paper, a highly artificial product, and accordingly the record gives a considerable percentage of fictitious fecundities. The effect of a mixture of correlated and uncorrelated material on correlation and and variation is next inves-

tigated, and it is shown that the former is more seriously affected than the latter. Hence results based on variation are more likely to be trustworthy than those which use correlation. Incidentally the problem of the mixture of heterogeneous materials uncorrelated in themselves is investigated, and it is shown that a correlation will result in the mixture. This *spurious* correlation is of some importance for the question of mixtures of classes in fertility problems, but it is also significant of the general danger of heterogeneity in bio-statistical investigations, and further indicative of the possibility of creating correlation between two characters by breeding between small heterogeneous groups in which this correlation is zero. This illustration suffices to indicate how correlation between characters does not necessarily indicate a causal relationship.

6. Part II of the memoir deals with the inheritance of fertility in man. It is first shown by large numbers that fertility is undoubtedly inherited from mother to daughter, but that if we include all types of marriages the inheritance is largely screened by other factors. An attempt is made to remove one by one these factors, and the more stringently this is done the more nearly the regression of daughter on mother moves up towards the value required by the law of ancestral heredity. If we could take only marriages in which both daughter and mother were married during the whole of their fecund period there is little doubt that we should find inheritance according to the law of ancestral heredity. The sparseness of homogeneous material hinders, however, such an investigation.

The inheritance of fertility from father to son is then considered; this is really rather an inheritance of sterility or tendency to sterility, for the full fecundity of a man is not usually exhibited in mono-

gamic union. It is rather a problem of whether his fecundity lasts as long as his wife's. We find definite inheritance of this sterile tendency from father to son, although for the reason just given it falls below that indicated by the law of ancestral heredity.

Lastly, the inheritance of fertility in the woman through the male line is dealt with, and it is shown that a woman's fertility is as highly correlated with that of her paternal as with that of her maternal grandmother. In other words the latent character, fertility in the woman, is transmitted through the male line, and with an intensity which approximates to that required by the law of ancestral heredity. Incidentally the problem of 'heiresses' is dealt with. It is shown that in the case of women that are chiefly 'heiresses' there is at once a considerable drop in the correlation between their fertility and that of their mothers, while there is a small drop only in their average fertility. In other words, an 'heiress' is not to be looked upon as coming in general from a sterile stock, but as having a mother whose fertility has a fictitious value, *i. e.*, the apparent fertility of the record is not the potential fertility, the inherited character, in the mother. In other words, 'heiresses' are not as a rule due to sterile mothers, but in the bulk are due to such causes as late marriages, restraint, incompatibility of husband and wife, absence of sons or death of other children, etc.

7. Part III of the memoir contains the results of a somewhat laborious investigation into the fecundity of brood-mares, which has been a number of years in progress. Had better material been available for the inheritance of fecundity we would gladly have adopted it in preference to dealing with such an intricate subject as the breeding of race-horses. Unfortunately, the absence of place and means hindered any experimental investigation on our part

into the inheritance of fecundity in some simpler type of life. Such investigation ought certainly to be made by a trained biologist, with the knowledge and the laboratory at his disposal.

After discussing at length the steps taken by us to measure and tabulate the fecundity of brood-mares, we deduce the following conclusions:

(i.) Fecundity in the brood-mare is inherited from dam to mare.

(ii.) It is also inherited from grand-dam to mare through the dam.

In both cases the intensity is much less than would be indicated by the law of ancestral heredity, but the divergence is not such that it could not be accounted for by a percentage of fictitious values such as the peculiar conditions of horse-breeding warrant us in considering probable.

(iii.) The latent quality, fecundity in the brood-mare, is inherited through the sire; this is shown not only by the correlation between half-sisters, but by actual determination of the correlation between the latent character in the sire and the patent character in the daughter.

(iv.) The latent quality, fecundity in the brood-mare, is inherited by the stallion from his sire. This is shown not only by the fecundity correlation between a sire's daughters and his half-sisters, but also by a direct determination of the correlation between the latent quality in the stallion and in his sire.

In both these cases of latent qualities the law of inheritance approaches much more closely to that required by the Galtonian rule. This is probably due to the fact that the determination of the correlation is thrown back on the calculation of the means and variabilities of arrays, and not on the direct calculation of the correlation between fecundities, a large percentage of which are probably fictitious (see § 5).

8. Parts II and III accordingly force us

to the conclusion that fertility is inherited in man and fecundity in the horse, and, therefore, probably that both these characters are inherited in all types of life. It would, indeed, be difficult to explain by evolution the great variety of values these characters take in allied species if this were not true. That they are inherited according to the Galtonian rule seems to us very probable, but not demonstrated to certainty. It is a reasonable hypothesis until more data are forthcoming.

The memoir concludes with a discussion of the meaning of reproductive selection for the problem of evolution and with sixteen correlation tables, giving the dressed material on which our conclusions are based.

THE NEW YORK MEETING OF THE AMERICAN PHYSIOLOGICAL SOCIETY.

THE American Physiological Society held its eleventh annual meeting in New York, December 28, 29 and 30, 1898. The first day's sessions were held at the physiological laboratories of the College of Physicians and Surgeons, the medical school of Columbia University. The forenoon session of the second day consisted of a joint meeting of the Society and the American Psychological Association at Schermerhorn Hall, Columbia University; in the afternoon the members attended at the same place the joint meeting of the Affiliated Scientific Societies. The sessions of the third day were held at the physiological laboratories of the University and Bellevue Hospital Medical College. In attendance and the number of papers presented the meeting was the most successful yet held, and demonstrated the fact that a large amount of research in physiology is being carried on in the laboratories of this country.

The forenoon session of Wednesday, the first day, was devoted largely to the presentation of the chemico-physiological com-

munications. Professor J. J. Abel (Johns Hopkins) discussed 'Epinephrin, the active constituent of the suprarenal capsule, and its compounds.' He has succeeded in isolating from the suprarenal capsule a specific chemical body which produces the peculiar physiological effects heretofore recognized with extracts of the capsule. He has carefully determined its chemical properties and classes it with the alkaloids with the formula $C_{17}H_{15}NO_4$. Drs. J. B. Wallace and W. Mogk, through Professor G. C. Huber, presented a report of an experimental study upon the 'Action of suprarenal extract on the mammalian heart,' performed in the laboratory of Professor A. R. Cushny (Michigan University). The extract was found to stimulate the vagus center, thus inhibiting the heart, to stimulate the heart muscle directly and to cause a constriction of the systemic arterioles. Dr. Walter Jones (Johns Hopkins) and Professor R. H. Chittenden (Yale) reported the results of independent investigations of the melanines, the black pigment occurring in hair and in the skin of the negro. The former obtained the pigment from black horsehair by treatment with hydrochloric acid. Fusing with caustic potash gave a sulphur melaninic free, which when oxidized in an alkaline medium is easily decomposed into carbonic acid and ammonia, but in an acid medium yields certain more complex bodies. The facts presented by Professor Chittenden tended to show that melanines or melanine-like pigments can be prepared artificially from antialbumid and hemipeptone by long heating with 10% sulphuric acid at 100°C. The exact composition of the melanine thus formed depends largely upon the extent of the hydrolytic cleavage of the proteid. By invitation, Dr. Beattie Nesbitt (Toronto) read a paper on 'The presence of cholin and neurin in the intestinal canal during its complete

obstruction.' His experiments lead to the belief that complete occlusion of the small intestine at its lower end will give rise to the occurrence of cholin, neurin, and, perhaps, other bases, provided the food taken contains a considerable quantity of lecithin. Cholin is only slightly, neurin powerfully, toxic. Professor W. T. Porter (Harvard) reported further 'Experiments on the mammalian heart.' Experiments on the isolated ventricles supplied with blood through the coronary arteries and cut in various directions show that the synchronism of the ventricles is not dependent on nerve-cells, is probably maintained through muscular and not through nervous connections, and is not a function of the auricles, but is managed by the ventricles themselves. Dr. Reid Hunt (Johns Hopkins) gave an account of his extended researches on 'Direct and reflex acceleration of the mammalian heart.' The accelerator nerves exert a tonic action upon the heart. The accelerator centers show greater resistance to the action of drugs, etc., than do the cardio-inhibitory or the vaso-motor centers. Continued stimulation of the accelerator nerves causes genuine fatigue in the heart, and, if long continued, even death. Reflex acceleration is due usually, if not always, to an inhibition of the tonic activity of the vagi.

Dr. S. J. Meltzer (New York) opened the afternoon session with a paper on 'The causes of the orderly progress of the peristaltic movements in the œsophagus.' The author's experiments tend to harmonize the statement of Mosso, who found that division of the œsophagus does not prevent the progress of the peristalsis below the cut and concluded that the peristalsis is of central origin, and the statement of Wild, who found peristalsis to cease at the cut and inferred that its progress is of peripheral origin. The author proved that the difference in the results was due to the fact that Wild experimented on animals under deep

anæsthesia, while Mosso's animals were only lightly anæsthetized.

The greater part of the afternoon session was devoted to demonstrations and the exhibition of new apparatus. Professor G. Carl Huber (Michigan University) demonstrated methylene-blue preparations of sensory nerve-endings in tendon—Golgi's tendon corpuscles. Professor W. T. Porter (Harvard) demonstrated the coordination of the ventricles in the mammalian heart. The following exhibitions of apparatus were made: A convenient form of non-polarizable electrode, by Professor W. H. Howell (Johns Hopkins); new laboratory apparatus, by Dr. E. W. Scripture (Yale); an improved form of Ellis's piston recorder, by Professor W. P. Lombard (Michigan University); a simple etherizing bottle, by Dr. C. C. Stewart (Columbia); a simple oncometer, by Professor F. S. Lee (Columbia); a new respiration apparatus, by Professor F. S. Lee.

The papers presented at the joint session of the Society and the American Psychological Association on the forenoon of Thursday, the second day, were calculated to interest both physiologists and psychologists. After an address of welcome by Professor Münsterberg, the President of the Psychological Association, Professor Chittenden, the President of the Physiological Society, was called to the chair and the prepared program was entered upon. Professor J. McK. Cattell (Columbia) gave a descriptive exhibition of instruments for the study of movement and fatigue. Professor F. S. Lee (Columbia) presented the results of an extended series of experiments upon 'The nature of muscle fatigue.' The course of fatigue in the muscles of the frog, the turtle and the cat shows certain differences, the common element being a decrease of lifting power. The chief cause of muscle fatigue appears to be poisoning by fatigue substances. Fatigue is a protective phenomenon, pre-

venting the oncoming of exhaustion. Professor G. Carl Huber (Michigan) reported his 'Observations on the innervation of the intracranial vessels.' In the pia mater and the cranial dura mater of the dog, cat and rabbit two kinds of nerves were found, sensory and vasomotor, the former being medullated, the latter non-medullated. The latter were found to terminate in the muscular wall of the arteries. Professor C. F. Hodge (Clark University) reported upon a research undertaken with Mr. H. H. Goddard to test the possible amœboid movements of cortical nerve-cells. The brains of rested and fatigued animals were compared. All the experiments in which definite results were obtained confirmed De Moor's results, showing a contracted and varicose condition of the dendrites, and, moreover, extend our knowledge to include effects of normal fatigue. The experiments were fully controlled, the control specimens showing dendrites and contact granules uniformly expanded. Dr. G. W. Fitz (Harvard) exhibited a new chronoscope, in which the time is measured by the fall of water within a graduated glass tube. A valve at the lower end of the tube is opened and closed by electro-magnets connected with the keys of the reaction apparatus. By invitation Professor O. N. Rood (Columbia) exhibited his flicker photometer. Professor Münsterberg discussed 'The physiological basis of mental life.' Professor G. T. W. Patrick (Iowa) discussed 'The confusion of tastes and odors.' Dr. E. W. Scripture gave an exhibition of methods of demonstrating the physiology and psychology of color.

At the joint meeting of the Affiliated Societies, on Thursday afternoon, in the discussion upon 'Advances in methods of teaching,' Professor W. T. Porter read a paper upon 'The teaching of physiology in medical schools.'

At the first session on Friday, the third

day, Professor Chittenden exhibited a convenient form of sphygmograph. Professor Graham Lusk (University-Bellevue), reported for Mr. W. H. Parker on 'The maximum production of hippuric acid in rabbits.' If benzoic acid be fed to rabbits in quantity just sufficient to unite with the glycocoll formed in the animal, the nitrogen that is excreted in the hippuric acid is in a fixed ratio of about 1 : 20 to the total nitrogen of the urine. This indicates that about 5 % of the nitrogen of proteid may be eliminated in the form of glycocoll. The latter is probably a cleavage product of proteid to this extent. Professor Chittenden presented the results of 'A chemico-physiological study of certain derivatives of the proteids.' The paper dealt especially with the results obtained in a careful study of the physiological action of a large number of specific cleavage products of proteids when introduced directly into the circulation. Antipeptone, antialbumid, antialbumoses, protogelatose, deterogelatose, pure gelatine peptone and so-called hemipeptone were among the products studied. The influence on the blood-pressure, blood-coagulation, immunity, lymph flow, urinary secretion, etc., were all carefully studied and results of interest were obtained. Professor G. N. Stewart (Western Reserve) presented the results of numerous experiments on 'The molecular concentration and electrical conductivity of certain animal liquids with special reference to blood.' Professor H. P. Bowditch (Harvard) read for Dr. J. K. Mitchell a paper on 'The influence of massage upon the number of blood globules in the circulating blood.' In health massage increases the number of red corpuscles and to some extent their hæmoglobin value. In anæmia there is a very constant and large increase in the number of red corpuscles after massage. Anæmia may be due to a lack of activity or availability in the corpuscles. Dr. P. A. Levene (New York)

gave the results of his investigations on the tissues of the higher animals as to their power of combining iodide intramolecularly. After administering potassium iodine to fowls and analyzing during ten weeks the eggs and later the tissues, he concludes that the power of combining iodine in the organism belongs only to certain keratins, such as that of the hair, to certain proteids, such as that of the thyroid gland, and to certain fats. Professor Wesley Mills (McGill) spoke of the 'Correlation of the functional and anatomical development of the cerebrum.' Professor Chittenden reported progress in the investigation of the properties of the edible and poisonous fungi which was undertaken by a committee of the Society appointed for this purpose two years ago.

At the afternoon session on Friday, Professor G. Carl Huber presented 'A note on the sensory nerve-endings in the extrinsic eye-muscles of the rabbit—atypical motor endings of Retzius. The author has repeatedly observed these nerve-endings and gave reasons for believing them to be sensory and not motor. In the absence of Professor L. B. Mendel (Yale), a paper by him, on 'The paths of absorption from the peritoneal cavity,' was read by the President. In a number of experiments upon absorption it was observed that the solution employed appeared in the urine considerably earlier than in the lymph. The author is inclined to the blood-vessel theory of absorption. Drs. P. A. Levene and I. Levin (New York), made a preliminary communication on the absorption of the proteids. Because of their easy identification iodoproteids were studied, being injected into a loop of the intestine and later sought for in the lymph. The results were negative and in so far tend to confirm the accepted theory of absorption by the blood system. By invitation Professor E. O. Jordan (Chicago) gave the results of experiments upon 'The production of fluorescent

pigment by bacteria.' The presence of both phosphorus and sulphur is essential to the formation of this pigment. The relative fluorescogenic values of a variety of chemical bodies were studied. The presence of acid and diffuse daylight are unfavorable to pigment production. Professor C. F. Hodge described for Mr. H. H. Goddard a new brain microtome which is constructed on two new principles: the knife, which is stationary, is level in order to carry liquid in which the section floats, and the brain is moved against the knife. By invitation Dr. L. J. J. Muskens (New York) exhibited an instrument for measuring muscular tonicity in man.

In addition to the above papers, a number of others were read by title. The following were elected members of the Society: Professor W. O. Atwater (Wesleyan), Professor S. P. Budgett (Washington), Dr. A. M. Cleghorn (Harvard), Dr. W. J. Gies (Columbia), Professor W. S. Hall (Northwestern), Dr. Walter Jones (Johns Hopkins), Professor E. O. Jordan (Chicago), Dr. A. P. Mathews (Tufts), Professor B. Moore (Yale), Dr. C. C. Stewart (Columbia) and Professor F. F. Westbrook (Minnesota). There were elected as members of the Council for 1898-'99: Professors Chittenden, Howell, Lee, Lombard and Porter. The details of the establishment of the *American Journal of Physiology*, under the auspices of the Society, were presented and made a part of the records. The *Journal*, now in its second volume, has abundantly justified its existence.

FREDERIC S. LEE,
Secretary.

SCIENTIFIC BOOKS.

The Discharge of Electricity through Gases. By J. J. THOMSON. New York, Charles Scribner's Sons. 1898. Small 8vo. Pp. 203. Price, \$1.00.

This volume contains, in modified form, the four lectures delivered by Professor Thomson

on the occasion of the sesqui-centennial celebration at Princeton, in October, 1896. As the subject is one that is rapidly developing, the author has added the results of numerous investigations that have been published since that time; so that the present volume gives an excellent presentation of the subject as it now stands.

Although the electrical discharge in gases has been investigated in its various phases ever since the study of electricity itself began, it is only in the last five or six years that our knowledge of the subject has begun to take systematic and satisfactory form. Careful observations had been made by hundreds of physicists, and the scientific literature abounded with descriptions of phenomena of great interest and undoubted scientific importance. But our knowledge of the subject consisted of a mass of *isolated* facts; no satisfactory underlying theory had been found by which these facts could be correlated. The development of such a theory is largely due to Professor Thomson, and I know of no place where it is so satisfactorily treated as in the volume before us. The book is not one requiring the preparation of a specialist in order that it may be understood; the greater part can be read with pleasure and profit by one having only an elementary knowledge of electrical science. On the other hand, I should not speak of the book as containing merely a 'popular' account of the subject, especially if the word 'popular' is to be regarded as having the same significance as inaccurate. Writers of popular science are, unfortunately, only too prone to look upon the two words as synonymous. Professor Thomson, however, possesses the rare power of writing upon a difficult subject with scientific accuracy, and at the same time in such a way as to be intelligible to the lay reader.

The contents of the book are arranged under three chief sub-divisions, namely: the Discharge of Electricity through Gases; Photo-electric Effects, and Cathode Rays. This classification is not wholly satisfactory, for each sub-division contains a great deal more than is indicated by its title. But the numerous sub-headings, to which reference is made in the table of contents, make it a matter of no great difficulty to find any special topic sought. A fairly com-

plete series of references to original sources constitutes a feature that cannot be too highly commended.

To one unfamiliar with the subject the first twenty pages will probably prove the most difficult portion of the book. The topics there discussed are the various methods by which a gas may be electrified: for example, by chemical processes, by electrolysis, and by the splashing of liquids. The essential peculiarities of the conducting power of gases are first brought into prominence in the account of the effect of Röntgen rays in giving to a gas the power of conducting electricity. Only a few weeks after the discovery of the X-rays it was found that an electrified body rapidly lost its charge when exposed to these rays. This property of the new rays was independently and almost simultaneously discovered by at least five different physicists, Professor Thomson being one of these, and has since been the subject of numerous investigations. The subject is one in which experimental errors are especially difficult to avoid, and a great deal of confusion naturally existed at first regarding the laws of the phenomenon and the conditions of its occurrence. Practically all of the more reliable experiments are now seen to support the view that the discharge of an electrified body by the Röntgen rays is due to the fact that the gas surrounding the body is made a conductor by the action of these rays. It is thought that the condition developed in the gas is somewhat similar to that in an electrolyte, *i. e.*, ions are formed, some carrying positive charges and others negative charges. A charged body placed in the 'ionized' gas would attract one kind of ions and repel the other. Upon coming into contact with the charged body the ions are supposed to give up their charges and cease to exist as ions. The gas is thus rendered capable of conducting electricity in much the same manner that an electrolyte conducts. But an essential difference exists between the two cases, due to the fact that the ionized condition of the gas is only *temporary*; in less than a second after the Röntgen rays have ceased the ions have recombined and the gas is as good an insulator as ever.

Conducting power may be imparted to a gas

not only by the action of Röntgen rays, but also by extreme heat and by the chemical changes that occur in flames. These cases are considered in the second part of the book. Here also the effects are readily explained upon the theory that the conduction is electrolytic. In fact, it is the development of this theory in its application to the various types of gaseous conduction that constitutes the most characteristic feature of the book. An accidental error in one of the formulas on page 37, whose consequences appear also in some of the equations on the two succeeding pages, may cause annoyance to one reading hurriedly. A serious misprint occurs on page 42, where 10^{-11} appears several times as 10^{11} .

An interesting account is given, in the second division of the book, of the curious effect of light in causing the discharge of *negative* electricity. This effect is produced chiefly by the shorter light waves, and preeminently by the invisible ultra-violet rays of the spectrum. It depends not only upon the gas surrounding the charged body, but also upon the nature of the charged surface. The electro-positive metals, such as zinc, sodium and rubidium, show the effect best. The fact that phosphorescent substances are especially sensitive to this effect, though as yet unexplained, is of undoubted significance.

The third section of the book, devoted to cathode rays, contains an excellent account of the recent experiments on this subject. Such an account is of especial value because of the extraordinary rapidity with which our knowledge of these rays has advanced. It is interesting to note that the study of cathode rays, as well as the study of the other phenomena of vacuum tubes, has received a fresh impetus since the discovery of the X-rays; if this study leads to important discoveries, as it now seems almost certain to do, I think that these must be regarded as indirect results of the discovery of Röntgen.

It is quite out of the question to call attention in this brief review to the many interesting and important subjects that are discussed throughout the book. The discussion is often brief and lacking in the detail that would be useful to one making a specialty of the subject.

But the book is written by one whose own investigations have contributed largely to the development of each of the topics considered, and who is now engaged in further research along the same lines. This fact gives to the treatment a charm impossible of attainment otherwise, and adds to the book a suggestiveness and inspiration which must appeal to all who read it.

ERNEST MERRITT.

Text-book of Physiology. Edited by E. A. SCHÄFER, LL.D., F.R.S. Vol. I. New York, The Macmillan Co.

This new text-book of physiology follows out the idea of combining under one editorship the writings of different men who treat of the special subjects in physiology with which they have had personal and intimate experience. In the face of the great and ever widening scope of the science of physiology, no work of general authority can be written in any other manner to-day.

In illustration of this we find in this volume, which covers merely the chemical side of physiology, reference to fully six thousand original articles. The book is highly creditable to the eleven English physiologists who have contributed to it, and it strengthens the general opinion that in physiology the English are second only to the Germans. The Germans, however, have no such comprehensive and thorough reference text-book as this. The work is hardly one for medical students, but is intended for the teacher, for the advanced investigator, or for reference in the medical library.

The article on the chemistry of the digestive processes is ably written by B. Moore. He attacks the theory of the cleavage of proteid into two molecules, the 'hemipeptone' and 'antipeptone,' for example, and claims that the existence of the 'hemi-' bodies has never been proved. He suggests that trypsin may act on a single molecule of albumose which may yield a greater or lesser quantity of amido acids according to the albumose used, and that the residue of the molecule which cannot be further attacked by trypsin is antipeptone. In the discussion of the composition of the fæces, Moore, in common with almost every text-book of physiology, makes the mistake of giving too

important a place to the residues of the food stuffs, omitting to state that the fæces consists rather of the residues of the excretions which pour into the intestinal tract.

In the article on the 'Chemistry of Respiration,' written by M. S. Pembrey, the statement is made that in Voit's respiration apparatus the moisture expired by the animal may sometimes be deposited in the conducting tubes before reaching the vessel where it is caught and weighed. With proper manipulation, however, this does not take place, and such a statement should not be too lightly made when it tends to invalidate a large quantity of carefully executed work.

The articles by Schäfer himself are characterized by breadth of thought and a balanced judgment which often causes him to make clear a middle ground between opposing theories. In his article on the 'Mechanism of the Secretion of Milk' he is inclined to doubt that milk is the product of the bodily disintegration of the lactic cells, but that, as in formation of saliva, granules are extruded from the cells, which granules dissolve to form the milk.

J. H. Langley has written a very complete monograph on the subject of the Salivary Glands, which includes his own important work.

The other authors are W. D. Halliburton, Arthur Gramgee, E. Weymouth Reid, E. H. Starling, J. S. Edkins, D. Noël Paton and F. Gowland Hopkins, all familiar names to the working physiologist.

The edition published here is identical in make up to that published in England and is everything that could be desired.

GRAHAM LUSK.

UNIVERSITY AND BELLEVUE HOSPITAL
MEDICAL COLLEGE, NEW YORK CITY.

SCIENTIFIC YEARBOOKS.

THE second volume of *L'Année biologique*, edited by Professor Yves Delage and published at Paris by Schleicher frères, follows the excellent lines laid down in the first volume and represents the best work accomplished hitherto by the various yearbooks recently established in France. The subjects are treated under twenty chapters, each beginning with a critical

survey, usually written by MM. Delage and Poirault, followed by a bibliography and abstracts of most of the papers. The digests are often detailed, *e. g.*, the notice of Cope's Primary Factors of Organic Evolution extends to 14 pp., and the account of the contents of a book or paper is usually clearly separated from such criticism as is given. The subjects treated and the number of titles given are as follows:

The cell, 171.
Sexual products and fertilization, 8.
Parthenogenesis, 6.
Asexual reproduction, 12.
Ontogenesis, 52.
Monstrosities, 71.
Regeneration, 46.
Grafting, 10.
Sex and sexual characters, 28.
Polymorphism, metamorphism and the alternation of generations, 29.
Latent characters, *vacat*.
Correlation, 26.
Death, immortality, the germ plasm, 10.
Morphology and general physiology, 275.
Heredity, 57.
Variation, 78.
The origin of species, 110.
Geographic distribution, 50.
The nervous system and mental functions, 203.
General theories, 48.

It is unfortunate that this recently-issued volume refers to 1896, instead of 1897, but the preparation of these 808 large pages represents a great amount of labor for which all students of the biological sciences should be grateful.

M. BINET's *L'Année psychologique* (Schleicher, Paris) combines the publication of special papers with a review of the progress of psychology in 1897. MM. Binet and Vaschide contribute separately and in conjunction no less than twenty-two researches to the present volume, and there are in addition two papers by M. Bourdon and one by M. Leclère. The papers, which deserve special review, are chiefly concerned with the individual differences of school children and contain many interesting suggestions, though, as a rule, the work is not carried far enough to secure definite results. The bibliography, compiled in the first instance by Drs. Farrand and Warren for *The Psychological Review*, contains 2,465 titles, and

about 90 of these papers are abstracted and reviewed, chiefly by M. Binet.

L'Année philosophique, of which M. Pillon is the editor and Alcan the publisher, in the issue for 1897 reaches its eighth volume. It contains articles by M. Renouvier on the idea of God, by M. Dauriæ on the philosophy of Paul Janet, and by the editor on Bayle and the altruism of Epicurus. The editor also offers a review of French philosophical publications extending to 140 pages. There is no bibliography.

MESSRS. LEMCKE AND BUECHNER, New York, are the American agents of a newly established bibliography of French periodicals, edited by M. Jordell. The example set in America was last year followed in Germany, and we are now glad to welcome a similar enterprise in France. In this first issue 146 periodicals are included, a subject index and an authors' index being provided. Scientific journals are not, as a rule, considered, but it is exactly articles that appear in the general journals that are most likely to escape the attention of scientific men, and the usefulness to them of such an index is evident. It should be accessible in all the larger libraries.

GENERAL.

It is stated that progress has been made with the preparation, for publication, of the extensive scientific material collected during the voyage of the *Fram*, and that there is a likelihood that the first volume of memoirs will be issued during the coming summer or autumn. The collection will be in quarto form, and the separate memoirs will be the work of a number of specialists in the subjects treated, each being paged separately. The total number will probably be about twenty, forming from three to five volumes. The memoirs will be published at the expense of the Nansen Fund for the advancement of science.

A QUARTO memoir upon *Polypterus* is being projected at Columbia University as the result of the Senff Expedition to the Nile. Specialists in the nerves, muscles, blood vessels and visceral anatomy will divide the work, which is designed to be of the most exhaustive character. Mr. Harrington is taking charge of the distribution of the Senff collection

to specialists in all parts of the country and in Europe, with the understanding that the results will be published by the New York Academy of Science, and thus constitute a special and uniform series, which can finally be issued in compact form.

PROFESSOR TITCHENER, of Cornell University, is preparing for publication early in the fall 'A Laboratory Manual of Experimental Psychology,' which will be published by The Macmillan Company. The work will be in two volumes and will detail an elementary course of laboratory work. The first volume will deal with qualitative analysis, the second with the exact measurement of mental processes. Each volume will be published in a student's and a teacher's edition, the former giving instructions as regards the conduct of experiments, control of introspection, etc., and the latter furnishing references, cognate questions and exercises and standard results.

BOOKS RECEIVED.

In the Australian Bush and the Coast of the Coral Sea.

RICHARD SEMON. London and New York, The Macmillan Company. 1899. Pp. xii + 552. \$6.50.

The Principles of Bacteriology. FERDINAND HUEPPE.

Translated by DR. E. O. JORDAN. Chicago, The Open Court Publishing Co. 1899. Pp. viii + 467. \$1.75.

The Dawn of Reason or Mental Traits in the Lower Animals. JAMES WEIR.

New York and London, The Macmillan Company. 1899. Pp. xiii + 234. \$1.25.

A Brief Introduction to Modern Philosophy. ARTHUR

KENYON ROGERS. New York and London, The Macmillan Company. 1899. Pp. viii + 360.

The Story of the Cotton Plant. F. WILKINSON.

New York, D. Appleton & Co. 1899. Pp. 191.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Physical Chemistry, January.

'Pressure temperature Diagrams for Binary Systems,' by Wilder D. Bancroft. 'The Dissociative Power of Solvents,' by Louis Kahlenberg and Azariah T. Lincoln: a study of electrical conductivity of a number of salts in non-aqueous solutions, more fully noticed in 'Notes on Inorganic Chemistry.' 'Boiling-point curves,' by E. F. Thayer: the boiling point curves for mixtures of alcohol and chloroform,

acetone and alcohol, and chloroform and acetone; it is found that a mixture of benzene and alcohol with 38.5% alcohol distils unchanged at 66.7° under 737 mm. pressure; chloroform and alcohol with 7% alcohol distils without change at 58.5° under 732.5 mm.; and chloroform and acetone with 19% acetone distils unchanged at 63.4° under 737.1 mm.; the boiling points of all mixtures of alcohol and acetone lie between the boiling points of pure alcohol and pure acetone. 'Reversible Reactions,' by John Waddell: a mathematical paper on the conversion of ammonium cyanate into urea, criticising a recent paper by Walker and Hambly in the *Journal of the Chemical Society*.

'SCIENTIFIC vs. Poetic Study of Education' is the title of the opening article, by Charles DeGarmo, in the *March Educational Review* (Holt & Co.). Other articles in the number will be: 'The High School Principal,' by John Tetlow; 'A School-Garden in Thuringia' (Illustrated), by Herman T. Lukens; 'Educational Value of Bird-Study,' by Frank M. Chapman; 'Vacation Schools,' by Charles Mulford Robinson; 'Report of the Chicago Educational Commission'; 'Fraudulent Diplomas and State Supervision,' by Henry Wade Rogers; 'School Supervision in New York State,' by Walter S. Allerton.

THE Geographical Association of Great Britain, at its annual meeting, on January 11th, adopted the *Journal of School Geography*, edited by Professor R. E. Dodge, New York, as its medium for the publication of information of service to teachers of geography.

SOCIETIES AND ACADEMIES.

WASHINGTON BOTANICAL CLUB.

THE third regular meeting was held February 1, 1899, at the residence of Mr. J. G. Smith.

Mr. C. L. Shear exhibited and discussed a parasitic fungus found on *Abies concolor* and *Picea Engelmannii* in the subalpine regions of the Rocky Mountains. This fungus attacks the lower branches of the younger trees, first forming a brown, felt-like layer over the branch and gradually spreading until frequently a foot or more of the branch is enveloped and killed. The fungus is closely related to *Herpotricha*

nigra Hartig, which is frequent on conifers in similar regions in Europe. Though not agreeing exactly with the description, it seems to be what was first described by Professor C. H. Peck in Hayden's Report as *Sphaeria Coulteri*.

Under the title 'Plant Formations of Western Lake Erie' a brief account was given, by Mr. A. J. Pieters, of the swamp formation and of the aquatic plant formation of the Put-in-Bay region. The extensive swamps on the main land at East Harbor are made up of various plant associations in each of which there is a dominant species, while in the other, dominant species of the formation are nearly or quite excluded, though many smaller forms are present everywhere if the depth of water does not prevent. The *Scirpus Americanus* Association is characteristic of the beach either when this is subject to heavy wave action or on dry sand bars; it also occurs in lagoons behind the bars. Throughout the swamp the different associations succeed each other, their arrangement being sometimes dependent upon depth of water, while at other times no relation could be detected between depth of water or character of bottom and the presence of the dominant species.

The aquatic plant formation was classified provisionally into associations which were grouped under two headings: *a*, free swimming forms; *b*, attached species. Three associations were recognized under the first:

1. The Plankton. This includes the free swimming, microscopic forms in deep water.
2. The Utricularia Association. Rootless, fine-leaved phanerogams and masses of algæ floating free beneath the surface in quiet water.
3. The Lemna Association. Small phanerogams floating free on the surface of the water.

Five associations of attached forms were recognized:

4. The Cladophora Association. Algæ attached to stones on the bottom or to the submerged stems of plants.
5. The Desmid Association. Mostly unicellular algæ lightly attached to fine-leaved phanerogams in quiet water.
6. The Chara Association. Low-growing plants covering the bottoms of shallow bays or pools.

7. The Potamogeton Association. Plants reaching nearly or quite to the surface, with long internodes and variously shaped leaves rooting in the mud and growing in water from one to ten feet deep.

8. The Nelumbo Association. Plants rooting the bottom and having floating or both floating and aerial leaves.

Two or more of these associations often occupy portions of the same area, but the plants of each association differ in their habits and usually remain distinct from those of other associations; not infrequently new combinations arise, the species of any association not always remaining where it is commonly found. This arrangement, however, expresses in the main the grouping of the plants as found in the waters and swamps of western Lake Erie.

Mr. C. L. Pollard exhibited specimens of two proposed new species of *Viola*. One of these is from Vermont and is related to *V. blanda* Willd.; it is conspicuous, however, for its large flowers, robust habit and unusually-developed rootstock. The other plant comes from southern California and belongs to the *Chrysanthæ*; it has very glaucous foliage and flowers half the size of *V. Douglasii*, its nearest congener.

The Club devoted the remainder of the evening to a general discussion on certain questions related to ecology.

CHARLES LOUIS POLLARD,
Secretary.

TORREY BOTANICAL CLUB—ANNUAL MEETING,
JANUARY 10.

NINETEEN new members were elected, and the previous board of officers, including, as President, Hon. Addison Brown; Treasurer, Maturin L. Delafield, Jr.; Recording Secretary, Edward S. Burgess; Editor, Lucien M. Underwood. Annual reports were presented, that of the Treasurer indicating a cash balance in hand.

The Recording Secretary, Professor Burgess, reported an average attendance of 39 at the 15 meetings held during the year, one death, a present active membership of 193, corresponding membership 140, honorary membership 3, total 336. The 27 scientific papers presented include 20 authors, among these non-resident

being Dr. Radlkofer, of Vienna, and Casimir De Candolle. About 20 new species have been described. Among the papers 6 were on taxonomic and other subjects relating to cryptogams, 2 on the nucleus, 2 were accompanied by lantern-views, and 2 by exhibits of photographs; 6 were followed by symposia for which general discussions had been prepared. Brief reports of collections and of botanical progress numbered 42. Two collations had marked the year's history, one tendered to the Club on March 8th, by the Teachers' College, and one tendered by the Club to visiting botanists, especially to members of the Society of Plant Morphology, at Columbia University, December 29th.

The editor, Professor Underwood, reported the regular monthly issue of the *Bulletin*, including 640 pages and 29 plates, with a balance to the credit of the *Bulletin*. Slight changes in the *Bulletin* include the introduction of author and subject head-lines, the arrangement of matter to begin each new article with a new page, and the use of improved plates. By discontinuing book reviews and miscellaneous notes more space has been gained for articles of research. The number of pages is itself 50 in excess of those of the preceding year. New numbers of the *Memoirs* are in preparation. A series of complete volumes of the *Bulletin* has been filed ready for sale, and surplus numbers inventoried and separated to supply the demand for single copies. An endowment fund is greatly desired, by which secure provision may be made for prompt publication and superior illustration of American botanical researches.

The report of the Field Committee, through its Chairman, Mr. W. A. Bastedo, enumerated 36 field meetings, all held in cooperation with the Brooklyn Institute; 3 of these were 3-day excursions in cooperation with the Philadelphia botanists, viz., at Decoration Day to Point Pleasant, N. J., at the Fourth of July to Stroudsburg, Pa., and at Labor Day to Whiting's, N. J.

In behalf of the Committee on Local Phanerogamic Flora, Dr. Britton referred to the work hitherto accomplished, as represented in Dr. Torrey's catalogue of 1819, and the two pre-

liminary catalogues published already by this Club, by Mr. W. H. Leggett in 1875-6, and by Britton, Sterns and Poggenburg in 1888. Local catalogues within our range include those of Suffolk County, L. I., by Miller and Young; of Staten Island, by Dr. Hollick and others; of New Jersey, by Dr. Britton, Dr. Rusby and others; of Long Island, by Dr. Jelliffe. Special interest attaches to Mr. Bicknell's work on the Westchester County Flora. It was desired that the new committee continue and combine the researches contributory to the ultimate publication of a comprehensive Flora of the Metropolitan District, adding such details as possible as to ecological and quantitative characters.

In behalf of the Committee on Local Cryptogamic Flora, Mrs. E. G. Britton reported that a catalogue of the Mosses of the Botanical Garden at Bronx Park is about to be published in its annual report.

Dr. Britton read a letter which he had received that morning from Mr. A. A. Heller, from Ponce, Porto Rico, announcing his arrival in health. He observed many interesting plants, as Crotons, in the vicinity of Ponce. Mr. Henshaw is about to join him, for further collections, particularly of living material for the Botanical Garden.

Dr. Britton also reported the formal opening of work on January 3d, toward the great range of Horticultural Houses for the Botanical Garden, which it is hoped may be ready for installation in October.

Dr. Rusby reported his possession of a manuscript catalogue of the economic plants of Cuba and Porto Rico, giving the botanic names, uses and common names, in about 8 volumes of 200 pages each. This is the work of our corresponding member, Professor De la Maza, of the University of Havana, who, although but a young man, has formed a large collection of plants there, comparing them carefully with the Charles Wright collection of Cuban plants, which is also in the University of Havana.

Dr. Britton also referred to the tour Dr. Fairchild is now taking along the Chilian coast in the hope of establishing some plant exchanges.

EDWARD S. BURGESS,

Secretary.

PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 495th meeting of the Society was held at 8 p. m., at the Cosmos Club, on February 4th. An informal communication was first presented by Dr. L. A. Bauer, read by Mr. J. F. Hayford, entitled 'Is the Principal Source of the Secular Variation of the Earth's Magnetism Within or Without the Earth's Crust?' The first regular paper was by Mr. J. H. Gore, on the 'Beginnings of Geodesy in the United States.' The second paper was by Mr. E. D. Preston, on 'Geodetic Operations in the United States.' Both of these papers will, probably, appear in full in *SCIENCE* within a short time.

E. D. PRESTON,
Secretary.

ALABAMA INDUSTRIAL AND SCIENTIFIC SOCIETY.

THE annual meeting of the Alabama Industrial and Scientific Society was held in the city of Birmingham, Ala., on Wednesday afternoon, February 1, 1899, with about twenty members in attendance. In the absence of the President, Professor M. C. Wilson, caused by a delayed train, the meeting was called to order by ex-President F. M. Jackson. After the reading of the minutes of the last meeting, the action of the Society at that meeting, recommending amendments to the State mining laws for the purpose of securing *monthly* returns of the production of the various minerals of the State, was reconsidered, and it was decided to recommend that the laws be amended so as to include only *yearly* returns of the production of coal, coke, iron ores, pig iron, limestone, dolomite, building stones, clays, bauxite, etc. The present law requires returns only from the producers of coal and coke.

Upon recommendation of the Council, three new members were elected and a number of papers accepted.

Under the head of new business, a resolution was adopted favoring the passage of United States Senate Resolution No. 205, 'To provide for a Division of Mines and Mining in the United States Geological Survey,' and the Secretary was instructed to communicate this resolution to the Alabama Senators and Congressmen, and also to bring the matter to the attention of the Commercial Club of Birmingham, with request that like action be taken by that body.

Upon the arrival of President Wilson, he read his address as retiring President, giving a general *résumé* of the work of the Society during the past year, and making some suggestions about its future work. The importance was also urged of establishing in the city of Birmingham a School of Natural Sciences, in which every youth in the limits of the city might have the opportunity of acquiring some scientific training, and especially in those branches of science which bear upon the manufacture of iron. The establishment of such a school would cause similar schools to spring up in the smaller towns and would be followed by industrial growth.

Papers were then read as follows: 'The Brown Ores at Leeds, in Jefferson County,' by J. W. Castleman, of the Sloss Iron and Steel Co. In this paper an account was given of the large deposits of brown ore recently developed by the Sloss company. 'On *Trichina spiralis*,' by Dr. John Y. Graham, of the State University. This paper, based upon original investigations by Dr. Graham, was illustrated by charts and by specimens under the microscope. 'On Roads and Road Making,' by Colonel Horace Harding. 'British Columbia and its Mineral Resources,' by Wm. M. Brewer. 'A Section through Red Mountain,' by A. W. Haskell.

The election of officers for the ensuing term was then taken up, with the following result: President, J. H. Fitts, of Tuscaloosa; Vice-Presidents, J. M. Garvin, of Rock Run, and J. H. McCune, of Woodward; Treasurer, Henry McCalley, of the University of Alabama; Secretary, Eugene A. Smith, University of Alabama. The Society then adjourned, to meet again on May 3d, next. After the adjournment the members of the Society and their invited guests partook of a banquet at the Morris Hotel.

EUGENE A. SMITH,
Secretary.

DISCUSSION AND CORRESPONDENCE.

ETHERION.

TO THE EDITOR OF SCIENCE: In a recent number of SCIENCE attention was called to what appeared to be an unreasonable attitude on the part of the editors of *Nature* towards

Mr. Charles F. Brush's paper on Etherion, an attitude, namely, which simply refused to accept Mr. Brush's results until they were demonstrated by the spectroscope. A recent criticism by M. Smoluchowski de Smolan in *Nature* for January 5th is, on the other hand, entirely reasonable, being, as it is, a fair criticism of Mr. Brush's work. The question whether heat conductivity can demonstrate the existence of an unknown thing, and the question whether Mr. Brush really found a gas which had one hundred times the thermal conductivity of hydrogen *at the same pressure*, are very different. It is this latter question which is raised by M. de Smolan. It seems probable, indeed, that the anomalous thermal conductivity found by Mr. Brush may have been due to his not having rigorously excluded water vapor, thus making his pressure determinations uncertain. We may soon expect an answer to this point from Mr. Brush himself.

W. S. FRANKLIN.

NOTES ON INORGANIC CHEMISTRY.

AN extended research has been made by E. Hintz on the effect of varying quantities of the rare earths on the luminosity of the mantels for the Welsbach burners. The results are published in the *Zeitschrift für analytische Chemie*. Comparing the oxides of thorium and cerium alone and mixed in varying proportions, and, using for comparison the number of liters of gas consumed per hour per Hefner light unit, it appears that the consumption for pure thoria is 50 and for pure ceria 61. With traces of ceria in thoria the consumption decreases, 0.1% ceria giving 6.7; 0.2%, 3.1, and 0.5%, 2.1. On the other hand, thoria added to ceria has much less effect, 30% thoria requiring 48; 60%, 31, and 80%, 12. The minimum consumption, that is, the greatest light efficiency, is reached with a mixture of 99% thoria and 1% ceria, with which the consumption of gas is only 1.4 liters per hour per Hefner unit. Some decrease of efficiency is noticed after several hundred hours' use. As regards the addition of other oxides to this 'normal' thoria-ceria mixture (99:1) 1% of neodymia, lanthana, yttria or zirconia has no effect; nor does 2% of the first three. Two per cent. of zirconia, however, diminishes

slightly the efficiency. Larger proportions of these oxids are prejudicial, especially those of neodymia and yttria.

COMMERCIAL calcium carbid has, as is well known, a reddish brown color. Moissan has lately studied this color and finds that it is due to the presence of iron, even traces of which give it a decided tint. He finds, however, that the pure calcium carbid crystals are colorless and transparent.

APPROPOS of the disputed occurrence of copper as a normal constituent of plants, Professor G. B. Frankforter, of the University of Minnesota, describes, in the last *Chemical News*, a very interesting occurrence of metallic copper disseminated in the pores of an oak tree in Minneapolis. The tree had died, and, on cutting it up, the presence of copper was so noticeable as to attract attention. Microscopic examination showed that only the outer annual rings contained an appreciable quantity of the metal, which was in the form of fine flakes, some of them 1.5 mm. in diameter. The copper appeared to be very pure. It seemed as if the tree had begun to absorb the metal only in the last few years, and that this had occasioned its death. The origin of the copper was uncertain, though the soil is known to contain native copper. The fact that the copper was in the native state would raise the question as to whether this is the usual form in which it occurs in plants. Another question might be raised as to whether plants take up any of the copper which is so largely used in fungicides, and as to whether this would eventually destroy a tree on which it was used.

UP to within a comparatively short time the physical chemistry of solutions has been almost confined to those in which the solvent is water. Attention is now being turned to other solutions, and very interesting questions arise as to the applicability of the theory of electrolytic dissociation and other theories which have been worked out only with aqueous solutions. We have already noticed in these columns the work of E. C. Franklin, of the University of Kansas, on liquid ammonia as a solvent. In the January number of the *Journal of Physical Chemistry*, L. Kahlenberg and A. T. Lincoln, of the University of Wisconsin, detail a number of experiments

with different non-aqueous solvents as to electrical conductivity. The solvents used were methyl and ethyl alcohol, acetone, ethyl acetate, benzaldehyde, and nitro-benzene. The substances dissolved were the chlorids of iron, antimony, bismuth, arsenic, tin and phosphorus. The molecular weights were also determined by freezing point depression with nitrobenzene as a solvent. The results obtained are not uniform enough, nor large enough in number, to be used for any generalization, but the following significant sentences occur at the close of the paper: "The general outlook at present appears to be that, in order to harmonize the molecular-weight determinations in many non-aqueous solutions with the relatively high electrical conductivity of the latter, the assumption that combination between solvent and dissolved substance takes place will have to be made. *Can it be true that, after its glorious success in explaining the properties of aqueous solutions of acids, bases and salts, the dissociation theory will need the help of its old rival, the hydrate theory (perhaps in a somewhat modified form), to explain the facts in the case of non-aqueous solutions?*" The authors call attention to the ideas of Werner regarding the existence of hydrated metal ions in solution, a theory which partakes of the nature of the two rival theories of solution. While Werner's theory may be in many respects unsatisfactory, it deserves to be better known among chemists, and may foreshadow something of the direction chemical thought will take, in the development out of the present valence theories.

J. L. H.

CURRENT NOTES ON METEOROLOGY.

WATERSPOUTS OFF THE COAST OF NEW SOUTH WALES.

AN incident quite unique in the history of waterspout observation occurred on May 16, 1898, off Eden, New South Wales. On this day fourteen complete waterspouts, and six others, more or less incomplete, occurred in the space of five hours. It so happened that a mining engineer, Mr. D. R. Crichton, was engaged in making certain observations with a theodolite in Eden at the time when the waterspouts began to form off-shore. Mr. Crichton made the most of his very exceptional opportunity;

watched the spouts carefully through the telescope of his theodolite, and obtained some definite measurements as to the height of the largest spout. According to his calculations the height above the sea of the top of the inverted cone was 5,014 ft. The cones at the top and bottom of the spout were about 100 ft. in diameter, and the length of each cone from its base to the points at which the sides of the spout appeared parallel was about 250 ft. Mr. H. C. Russell, the Government Astronomer of New South Wales, has published an admirable, illustrated account of this remarkable series of waterspouts, together with a record of previous waterspouts, and some observations as to the conditions under which these phenomena occur. (Journ. Roy. Soc., N.S.W., Vol. XXXII., 1898.)

ANNUAL REPORT OF THE CHIEF OF THE WEATHER BUREAU.

THE *Annual Report* of Professor Willis L. Moore, Chief of the Weather Bureau, emphasizes once again the wide scope of the work of the Bureau and the value of this work to the public at large. The extension of the meteorological service to include observations at various stations in the West Indies, Mexico and Colombia, has already been referred to in these Notes. The observations made during the International Cloud Year are under discussion and will soon be published. The total number of forecasts distributed during the year, exclusive of those published in the daily papers, was, approximately, 23,531,500. Sixty-four per cent. of this distribution was by logotype cards, sent through the mail or carried by messengers; 23% by maps and bulletins; 10% through cooperation of railroad, telegraph and telephone lines; 3% by telegraph and telephone lines at the expense of the Bureau. Weather maps to the number of 5,239,800 were distributed. A section of the Climate and Crop Service has been established in Alaska. A meteorological chart of the Great Lakes has been issued monthly during the season of navigation.

METEOROLOGICAL CHART OF THE GREAT LAKES.

THE *Meteorological Chart of the Great Lakes*, dated January 4th, contains a summary, for the year 1898, of the storms on the Lakes, the

number of disasters and of lives lost, the values of the vessels lost, and the causes of the disasters. Thirty-nine vessels were totally lost, all as the result of gales. Of the partial losses (104), 22 were due to fog and 82 to gales. The number of lives lost was 96. The relative frequency of fog over the Lakes during the season of navigation (April 1st to December 15th) is shown by five different styles of shading.

NOTES.

A NOTABLE work on the physiological effects of high altitudes has recently been issued. It is an English translation—entitled 'Life of Man on the High Alps' (London, 1898)—of a book originally written in Italian by Professor Angelo Mosso, of Turin. According to *Nature* (January 26th) this "is the first attempt that has been made to present the various complex physiological phenomena which man exhibits at high altitudes in such a form as to be easily understood by those who are not trained physiologists."

In his Presidential address before the Royal Meteorological Society on January 18th, Mr. F. C. Bayard stated that in the British Isles only two shillings and sixpence per square mile is voted by the government for the support of meteorology. This amounts to one-third of a farthing per head.

R. DEC. WARD.

HARVARD UNIVERSITY.

CURRENT NOTES ON ANTHROPOLOGY.

MEGALITHIC MONUMENTS.

AT the last meeting of the German Anthropological Society, Professor Virchow delivered a long and elaborate address on the 'megalithic monuments' of Europe. He rejected all theories so far advanced as to their builders, and left it as a question for the future to settle.

Mr. W. C. Borlase, probably the best authority on the subject, is the author of a work in three volumes on 'The Dolmens of Ireland.' His descriptions are excellent, but in his search for their constructors he loses himself in the maze of Irish legendary lore, and falls into the common error of supposing that because the same stories are told and the same superstitious practices obtain concerning these monuments in Ireland, Spain, France and Germany there must have been relations and borrowing. This

mistake in his reasoning is well pointed out by Mr. Alfred Nutt in a review of the work in the *Folklore Journal* (March, 1898). Identity of psychology, he justly insists, is the true explanation.

THE MEANING OF PRIMITIVE ORNAMENT.

ON few questions in ethnology is there wider diversity of opinion than about the intention of primitive decoration. Does it arise from a mere love of imitation, without further idea? Is it mystical and symbolic, in some way an expression of the religious sentiments? Is it due to utilitarian aims, a sort of graphic method? Or is it the expression of the sense of the beautiful, genuinely artistic?

Each of these opinions has its defenders. In the *Internat. Archiv für Ethnographie* (1898, Heft II.) Van Panhuys caustically reviews the question, and concludes with the pertinent inquiries: Cannot the same decorative designs arise among peoples who have had no relations with each other? Why must the meaning or origin of these designs be everywhere the same? These are, indeed, pointed and pertinent interrogatories and hint at the true solution of the inquiry.

GENEALOGY AS A BRANCH OF ANTHROPOLOGY.

IN his opening address before the last meeting of the German Anthropological Society, Professor Johannes Ranke emphasized the value of genealogical investigation as an aid to anthropology. By it we learn the facts of heredity, the influence of kinship, the consequences of intermarriage of relations, the permanence or variation in family traits, psychical and physiological peculiarities and their transmission, the tendency to reversion of types, the effect on the children of marriages at different ages, and many more points of very great interest.

For genealogy, however, to be thus promoted to the dignity of a science it is necessary that those who cultivate it should be willing to tell the truth about the family trees in which they are interested; and in America, notably in Philadelphia, they are yet a long way off from taking this position.

D. G. BRINTON.

UNIVERSITY OF PENNSYLVANIA.

SCIENTIFIC NOTES AND NEWS.

THE Berlin Academy of Sciences has conferred its Helmholtz medal on Professor Virchow. It was established on Helmholtz's birthday in 1892, and has since been conferred on Du Bois-Reymond, Weierstrass and Lord Kelvin.

DR. ROUX, of the Pasteur Institute, has been elected a member of the Agricultural Section of the Paris Academy of Sciences, in the room of the late M. Aimé Girard. M. Risler, Director of the Agricultural Institute, received fourteen votes, and M. Maquenne, professor of the applications of physics to agriculture in the Paris Museum, received two votes, as compared with forty-one for M. Roux.

AT the last meeting of the British Institution of Electrical Engineers, Lord Kelvin was elected an honorary member. Lord Kelvin is the oldest surviving past President of the Institution, having held the office of President in 1874.

THE Hungarian Society of Natural History has elected M. de Freycinet a corresponding member, and has translated into Hungarian his essay, 'Sur la philosophie des sciences.' This translation is distributed among the members of the Society, which, we are glad to learn, number 8,000.

INVITATIONS have been issued for the celebration, at Cambridge, of the jubilee of Professor Sir George Gabriel Stokes, to the plans for which we recently called attention. Sir George Stokes was elected Lucasian professor of mathematics on October 23, 1849. The ceremonies will take place on June 1st and 2nd of the present year.

M. PICARD, Commissioner-General of the Paris Exposition of 1900, has been elected an honorary member of the British Institution of Civil Engineers.

PROFESSOR E. B. WILSON, of Columbia University, after visiting the Naples Zoological Station, has gone to Egypt, and is endeavoring to follow up the work of Messrs. Hunt and Harrington in pursuit of the life-history of *Polypterus*.

THE Berlin Academy of Sciences, with the assistance of the Heckmann-Wentzel foundation, has undertaken to explore Lake Nyassa and the

surrounding regions, with a view to studying the fauna and flora. Dr. Fülleborn will act as zoologist and Dr. Götze as botanist of the expedition.

Nature states that Dr. Don Francisco P. Moreno, Director of the La Plata Museum, and Commissioner of the Argentine Republic in the boundary delimitation with Chile, has arrived in London from Buenos Ayres.

PROFESSOR F. KÜSTNER, Director of the Observatory at Bonn, has been appointed Director of the Hamburg Observatory, Professor G. Rümker having resigned this position on account of ill health.

MR. J. H. HOLLAND has been appointed Director of the Botanical Gardens in Calabar.

THE annual meeting of the Malacological Society, London, was held on February 9th. The Presidential Address was delivered by Lieut.-Colonel H. H. Godwin-Austen, F.R.S.

LECTURES on geology will be given at the American Museum of Natural History during March as follows: March 4th, Professor James F. Kemp, on 'The Newer Gold Regions of the West,' with especial reference to the Cripple Creek country of Colorado, Mercur, Utah, and the Yukon basin; March 11th, Mr. Walter H. Weed, of the United States Geological Survey, on 'The Gold and Silver Mines of Montana;' March 18th, Dr. Hienrich Ries, of Cornell University, on 'Clay and Its Uses;' March 25th, Dr. David T. Day, on 'The Geology of Petroleum.'

THE Vienna Medical Club has voted the sum of three hundred gold crowns for the foundation of a prize in memory of Dr. Hermann Franz Müller, whose recent death from the plague will be remembered.

WE learn from *Nature* that at its annual meeting, on January 10th, the Russian Academy of Sciences awarded its Helmersen premium to A. Mickwitz for his work, 'Die Brachiopoden. Gattung *Obolus*, Eichwald'; the Lomonosoff premium to N. I. Andrusoff for his work, 'The fossil and the living *Dreissenidae* of Eurasia'; to E. Burinsky, for his improvements in photography; and to P. I. Brounow, for his works in meteorology. The large Tolstoi medal was

awarded to L. Besser and K. Ballod, for their researches into the natality and mortality of the populations of European Russia, the Baltic provinces, and different countries of Europe, including Great Britain; and the small medal to P. G. Matsokin, for a MS. work on the half-breeds of Transbaikalia.

MR. E. A. MARTEL has been awarded the grand medal of the French 'Société de Topographie.'

THE second award of the Weber-Parkes prize and medals of the Royal College of Physicians of London (awarded triennially to the writer of the best essay upon some subject connected with the ætiology, prevention, pathology or treatment of tuberculosis, especially with reference to pulmonary consumption in man) will be made in 1900. The value of the prize is 150 guineas and a silver medal. A similar medal, distinguished as the second medal, will be awarded to the essayist who comes next in order of merit.

WE learn, with regret, of the death, from pneumonia, of Professor Wilbur Wilson Thoburn, professor of biomechanics, at Leland Stanford Jr. University.

WE regret also to record the following deaths: Dr. G. Wolffhügel, professor of hygiene in the University at Göttingen; Dr. Rupert Böck, professor of mechanics in the Technical Institute of Vienna, and Dr. Lench, assistant in the Observatory at Zurich.

IN the British House of Commons on February 8th Mr. Akers Douglas (Kent, St. Augustine's) said: "All the new buildings for South Kensington Museum on the east side of the Exhibition-road will be devoted to the art collections. The existing science building on the east side of the road will be the only portion which will continue to be used for science purposes. The new science buildings will be erected on the west side of the road. The plans have been prepared by the architect in communication with the officers of the art and science branches, and meet with the approval of the Lord President and his department. It is proposed to commence the new buildings in front of the South Kensington Museum within the next few weeks."

SOMETIME since we called attention to the appointment of a commission in France to consider the question of colonial botanical gardens and agricultural experiment stations. This commission has now recommended that a station be established in each of the French colonies and a central station for the distribution of seeds and plants. A decree has been issued organizing such a station at Vincennes and M. Jean Dybowski has been appointed its director.

PLANS have been made for the erection of a State Meteorological Station on the summit of Schneekope, one of the Riesengebirge, Silesia, which is 1,605 meters in height. A scientific observer will be stationed in the observatory.

It is feared that the instruments of the Manila Observatory have been injured by the recent battles. The Observatory, is well equipped for meteorological and seismological observations, and its publications have been of much scientific value.

THE Brooklyn Institute will establish in its museum a department in which natural history and technology will be exhibited in a manner that will interest and instruct children. There are such museums in foreign cities, but not, it is said, elsewhere in America.

MR. ANDREW CARNEGIE, in addition to offering \$250,000 for a free library in Washington, and \$100,000 for a free library at Atlanta, has also offered to provide libraries for Richmond, Va., and Bellefonte, Pa. Mr. Carnegie has already given more than \$8,000,000 for the establishment of free libraries.

OPEN competitive merit examinations will be held March 1st to 7th, 1899, in various cities throughout New York State for the positions mentioned below. Exact dates will be fixed later for the various cities, and candidates having applications on file will be given ample notice of the time and place of examination most convenient to their place of residence. Intending competitors must file applications in the office of the Commissioner before February 28th. Assistant Commissioner of Agriculture, Third Division.—Applicants must be residents of this division, which includes the counties of Columbia, Delaware, Dutchess, Greene, Orange, Putnam, Rockland, Sullivan, Ulster and part

of Westchester. Salary, \$1,500 per annum. The examination will relate entirely to the duties of the position, the experience of the candidate, his knowledge of agriculture and its interests in the division and his familiarity with the laws relating to the Department and its work. Assistant at the Agricultural Experiment Station, Jamaica, N. Y.—Candidates must have a practical knowledge of farm and garden work, and should have some training in the fundamentals of botany and entomology; they must also have the knowledge of the care of a forcing house, spraying and the supervision of other experiments conducted by such a station. Salary, \$600 per annum. The examination will relate wholly to the duties of the position and the knowledge and experience required for their performance. Time allowed, seven hours. Library Assistant, State Library.—Salaries, \$30 to \$50 per month. The examination will cover cataloguing, classification, indexing, library economy, indexing and handwriting.

THE Department of State has received from the German embassy at Washington, under date of January 21, 1899, notice of the international veterinary congress to be held at Baden on August 9–14, 1899. The subjects to be discussed include prophylactic measures to prevent the spread of cattle diseases by the export of animals, treatment of tuberculosis in domestic animals, use of flesh and milk of animals affected by tuberculosis and requirements for inspection of meat, cure of foot and mouth disease and diseases of swine, dissemination of veterinary instruction, preparation of a uniform anatomical nomenclature in veterinary medicine and cure of rabies. The members of the congress shall consist of delegates from foreign countries and the German Empire, representatives of veterinary schools who are designated to the committee, delegates of veterinary and agricultural societies, representatives of state and communal offices of public health and public hygienic institutes, and veterinarians who record their names and pay 12 Marks.

AT a meeting held January 20th by the Belgian Society of Electricians (M. Emile Closset, President) it was decided to open an exposition of electrical appliances applicable to domestic

uses. The exposition will be held next May, in the new post and telegraph office, Place de la Monnaie, Brussels.

THE Twenty-eighth Congress of the German Surgical Society will be held in the Langenbeckhaus, Berlin, from April 5th to 8th, under the presidency of Professor Eugen Hahn.

A SUIT is being brought by the Treasurer of the New England Anti-vivisection Society to prevent the former President from disposing of the funds of the Society. A lawsuit is, perhaps, the most innocent disposition that could be made of these funds.

FURTHER information has been sent concerning the Seventh International Geographical Congress, which will meet in Berlin at the end of September. Among the subjects to be brought up are: Proposal to introduce international uniformity in the methodical treatment of various subjects, such as the problem of the tides, the conventional signs on maps, the nomenclature and delimitation of oceans and seas, the attachment of the scale to every map, the mode of arranging meteorological tables, etc. There are also suggestions for joint international work: (1) in collecting materials of every kind referring to floating ice, to earthquakes, to the utilization of arid lands, etc.; (2) in the exploration of the Antarctic regions; (3) in the systematic exploration of the oceans; (4) a suggestion, dating from former congresses, and which is again to be discussed at Berlin, refers to the execution of an international geographical bibliography. It appears that this will be finally disposed of at Berlin. (5) Another important subject, dating from the meeting of Berne, is Professor Penck's well-known project for the construction of a map of the world on the scale of 1 to 1,000,000. It is intended also to make arrangements, if possible, for the more efficient work of the committees appointed by the Congress, as, for example, by paying for the traveling expenses of members in order that meetings may be held.

THE *British Medical Journal* reports that the first meeting of the 'Association des Anatomistes,' which is intended to form the nucleus of a 'Latin Anatomical Association,' was held

recently in Paris, under the presidency of the distinguished embryologist, Professor Balbiani, of the Collège de France. The Vice-Presidents were Professors Mathias Duval, of Paris; Renaut, of Lyons, and Romiti, of Pisa. Professor Nicolas, of Nancy, was appointed Secretary, Professor Ranvier, of Paris, and Professor Van Bambeke, of Ghent, were elected Honorary Presidents, in addition to a considerable number of French teachers and investigators. Several foreign anatomists were present, including Professors Van der Stricht, of Ghent; Van Gehuchten, of Louvain, and Mitrophanoff, of Warsaw. The next meeting of the new Association will be held in connection with that of the Anatomical Section of the International Medical Congress to be held in Paris in 1900.

WE learn from the *British Medical Journal* that on February 2d a new Bacteriological Institute was formally opened in the University of Louvain. The Institute is on a large scale, and the installation and equipment are in accordance with the most advanced ideas. Every facility for research is provided. The stables, kennels and other quarters for animals are built around a vast garden, and all the arrangements show careful regard for the health and comfort of the animals. Professor Denys began his work fifteen years ago in two small rooms, which later expanded into a respectable laboratory, and now have developed into a scientific palace. Giving an account of the work that had been done, he stated that more than 80 original researches had come from it, besides 25 presented for travelling scholarships, 23 of which had gained a prize of £160. A special department in the new Institute will be devoted to the preparation of therapeutic serums of different kinds, tuberculin, etc. At the Congress on Tuberculosis held in Paris last summer Professor Denys gave an account of a new tuberculin which he had used with considerable success; he proposes to continue his work in this field, and is hopeful of success. A feature in the Institute which is likely to be particularly useful is an out-patient department for sufferers from tuberculosis and other microbic diseases who receive serum-therapeutic treatment adapted to their complaints, only substances which have been tested by experimentation on

animals being used. Already numbers of patients, mostly the subjects of phthisis, are in regular attendance.

UNIVERSITY AND EDUCATIONAL NEWS.

THE Trustees of Trinity College have decided to erect a Natural Science Hall at a cost of \$40,000.

THE bi-centennial celebration of Yale University will begin on Sunday, October 20, 1901, and will continue for four days. On Wednesday a commemorative address will be made and honorary degrees will be conferred.

THE fund which since 1880 has been collecting for a retirement fund for professors of Harvard University has now reached \$340,000, and the plan will be put into effect at the beginning of the next academic year. Professors who have served for twenty years and who are over sixty years old will be allowed one-third salary, with an increase for longer terms of service, which, however, is not to exceed two-thirds of the salary.

THE following table shows the enrollment of the University of Michigan, February 9, 1899:

Literary department.....	1,271
Engineering department.....	247
Medical department.....	421
Law department.....	745
Dental department.....	237
Homoeopathic department.....	61
Pharmaceutical department.....	78
Total.....	3,060

A MEETING was held in London on January 31st for the purpose of forming the Cambridge University Association, the chief object of which is to improve the financial condition of the University. The Duke of Devonshire, Chancellor of the University, presided and made an address. Other addresses were made by Dr. Hill, the Vice-Chancellor; Professor Jebb, Master of Trinity; Sir Richard Webster, Professor Allbutt, Professor Ewing, Lord Rothschild and the Bishop of London. It was stated that the sum of about \$2,500,000 was needed. Toward this sum the Duke of Devonshire and Lord Rothschild each subscribed £10,000. It was also stated that the Drapers'

Company would subscribe £800 a year for ten years in support of a professorship of agriculture. Since the meeting Sir Walter Gilby has subscribed £200 for ten years for a readership of agriculture, and in addition to smaller subscriptions £3,000 toward the general fund has been given by Mr. Benjamin L. Cohen.

DR. J. C. BRANNER, professor of geology in Leland Stanford Jr. University, has been appointed Vice-President of the University.

THE chairs of pathology vacant at Cambridge, by the death of Professor Kanthack, and at Glasgow, by the death of Professor Coats, will be filled during March. In accordance with the English custom, applications for these chairs should be presented to the University authorities.

M. RIEFFEL-SCHIRMER, professor of geography at Lyons, has been appointed lecturer in the University of Paris for the present year, in the place of M. Gallois, who has been given leave of absence.

THE John Lucas Walker Studentship, of the annual value of £200, for the furtherance of original research in pathology, has been conferred upon Mr. Edward Sydney St. Barbe Sladen, M.A., M.D., B.C., of Gonville and Caius College. The studentship is tenable for three years.

DR. HÖLDER, professor of mathematics of the University at Königsberg, has been called to Leipzig, and will be succeeded at Königsberg by Dr. Schönflies, of Göttingen. Dr. Alois Lode has been made associate professor of hygiene at Innsbruck, and Dr. Helferich, of Greifswald, has been called to Kiel as successor to Professor v. Esmarch, who has retired. Dr. Otto Wiener, of Giessen, has been appointed to a full professorship of physics in the University at Leipzig, and Dr. Hans Held has been promoted to an assistant professorship of anatomy in the same University. Dr. Walter König has been appointed professor of theoretical physics in the University at Heidelberg, and Dr. Jakob Früh, professor of geography in the Polytechnic Institute at Zurich. Dr. Pelikan has been promoted to an assistant professorship of mineralogy in the German University at Prague.

SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; J. LE CONTE, Geology; W. M. DAVIS, Physiography; O. C. MARSH, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; HENRY F. OSBOEN, General Biology; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; J. McKEEN CATTELL, Psychology; DANIEL G. BRINTON, J. W. POWELL, Anthropology.

FRIDAY, MARCH 3, 1899.

CONTENTS:

<i>Geodetic Operations in the United States</i> : E. D. PRESTON.....	305
<i>The American Morphological Society</i> (I): PROFESSOR BASHFORD DEAN.....	311
<i>Association of American Anatomists</i> : DR. D. S. LAMB.....	320
<i>American Mathematical Society</i> : PROFESSOR F. N. COLE.....	322
<i>The Nomenclature of the Hyoid in Birds</i> : F. A. LUCAS.....	323
<i>Scientific Books</i> :—	
<i>Whitehead's Treatise on Universal Algebra</i> : DR. ALEXANDER MACFARLANE. <i>Bailey on the Principles of Agriculture</i> : ELISHA WILSON MORSE. <i>Beddard's Elementary Zoology</i> : PROFESSOR CHARLES WRIGHT DODGE. <i>Peabody's Laboratory Exercises in Anatomy and Physiology</i> : PROFESSOR FREDERIC S. LEE. <i>Books Received</i> .	324
<i>Societies and Academies</i> :—	
<i>The Biological Society of Washington</i> : DR. O. F. COOK. <i>The Chemical Society of Washington</i> : WILLIAM KRUG. <i>The New York Section of the American Chemical Society</i> : DR. DURAND WOODMAN. <i>Geological Conference and Students' Club of Harvard University</i> : J. M. BOUTWELL. <i>Academy of Natural Sciences of Philadelphia</i> : DR. E. J. NOLAN.....	332
<i>Notes on Physics</i> :—	
<i>The Measurement of Inductance</i> : W. S. F.....	336
<i>Notes on Inorganic Chemistry</i> : J. L. H.....	337
<i>Current Notes on Anthropology</i> :—	
<i>Linguistics of the Chaco</i> ; <i>The Craniology of Criminals</i> ; <i>The Folk-lore of the Fjort</i> : PROFESSOR D. G. BRINTON.....	338
<i>Scientific Notes and News</i>	339
<i>University and Educational News</i> :—	
<i>Mr. Agassiz and Harvard University</i> ; <i>The Climatological Laboratory of the University of New Mexico</i> ; <i>General</i>	341

MSB. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

GEODETIC OPERATIONS IN THE UNITED STATES.*

THE geodetic operations in the United States, as executed by the Coast and Geodetic Survey, may be grouped into three distinct periods of time. The work was authorized by Congress in 1807, but a quarter of a century elapsed before anything was done in the field worthy of the name of Geodesy. This closed the first period, which may be characterized as the era of preparation and education of public sentiment. In 1832 operations were begun with vigor, and the foundation was laid for a great national work. The Survey was conducted on the same general lines of policy for eleven years, when the reorganization of 1843 established its permanent status. No great deviation has since been made from this plan, which has now held for fifty-five years. If we eliminate the Civil War period of five years, during which work was suspended, and regard operations before the reorganization as of a preliminary nature, we have half a century of geodesy. During its comparatively short existence the Survey has been three times under the control of the Treasury Department, twice under the Navy, and once under law requiring its personnel to be army or navy officers. The direction of the work has, however, remained throughout

* Published by permission of the Superintendent of the U. S. Coast and Geodetic Survey.

in the hands of a civilian, and civilian methods have been applied in the administration. At the present time it has been continuously under the Treasury for a period of sixty-two years. Although statistics do not always give an adequate conception of the work to which they are supposed to bear testimony, a general idea of the activity displayed may be had from the following statement of work done :

- 350,000 square miles (906,500 sq. kilo.) of triangulation, embracing
- 15,000 stations for horizontal measures, and determining
- 28,500 geographical positions at which
- 1,000 astronomical coordinates have been observed.
- 38,500 square miles (99,710 sq. kilo.) of topography, embracing
- 11,600 miles (18,670 kilometers) of general coast line and more than
- 100,000 miles (160,900 kilometers) of shore line (rivers, etc.), also including
- 51,000 miles (82,080 kilometers) of roadways.
- 545,000 miles (877,100 kilometers) of sounding, covering
- 164,000 square miles (424,800 sq. kilo) of area, besides
- 93,000 miles (149,700 kilometers) of deep sea sounding, in which
- 14,000 bottom specimens were obtained.
- 4,600 original topographic and hydrographic sheets, from which
- 1,300,000 charts have been made and distributed ;
- 30,000 original volumes of observations, including magnetic records from
- 1,100 stations.

BASE LINES.

Two hundred and three base lines have been measured, of which nineteen, on account of their accuracy, length and geodetic connection, are classed as primary. The average length of these is 9,892 meters. The probable error, which includes both that of measurement and the comparison with the standard, is 22.2 millimeters, or about 1/445,000 of the length stated. Speaking of the three types of apparatus used in the

Survey, and referring now to errors of measurement purely, it may be said that with the different forms of metallic bars, compensating and otherwise, the error is one-millionth part of the length measured. With the tape line the accuracy may be increased to 1/2,000,000, while with a rod in melting ice 1/5,000,000 is easily attainable. In the first form the contacts are material ; in the last, optical ; with the tape they are linear. The cost is greatest for the rod in melting ice, and least with metallic bars.

Attention may here be called to a new form of base apparatus named the Duplex and designed by Assistant William Eimbeck. It consists of two bars, brass and steel, five meters in length, so arranged that the measure may be made with each component separately and simultaneously. It may also be employed as a Borda scale, or the temperature may be directly observed. Some unique features, which need not here be described, are employed in its manipulation. The Salt Lake base, measured in 1896, gave results with either component having a probable error of less than 1/5,000,000 part of the measured length.

TRIANGULATION AND ARCS.

The shore line of the United States, exclusive of Alaska, is 5,452 miles (8,774 kilometers). This has been covered by triangulation, with the exception of a few hundred miles on the northwest coast. An oblique arc of 22° has been measured from the northeast boundary in Maine, to the southwest limit of Alabama, on the Gulf of Mexico, and an arc of 49° on the 39th parallel of latitude has been completed, from the Atlantic to the Pacific. All of the New England States, a large part of the Middle ones, and considerable areas in the South and West, have been covered with triangulation. Adjacent regions have had careful reconnaissance. The work in this direction has been executed on a large and accurate

scale. The greatest triangle has sides of 133, 167 and 190 miles (214,269, and 306 kilometers). The highest station is over 14,000 feet (4,267 meters). Operations of such magnitude justify the introduction of refinements not usually employed. The latitudes are corrected for elevation, and the horizontal directions are changed, to reduce them to the sea level of the observed station. A distinctive feature in the final adjustment is the application of weights depending on both the station errors and those arising from the closing of figures. These are treated separately, but the final weights consist of two parts, one resulting from local conditions and varying with each direction, and the other deduced from the formation of triangles and remaining constant for the network under consideration. In the California work the probable error of a direction at any station was $0''.081$ while that from the closing of triangles was about twice as much. The latter necessarily includes the former. The two are separated by means of the formula

$$e_c = \sqrt{e_t^2 - e_s^2}$$

which gives the resulting combination error as $\pm 0''.169$. e_t is the probable error of a direction from the closing of triangles, and e_s is the average probable error of an observed direction from station adjustment. Each direction, therefore, enters the final adjustment with a weight derived from measures at its own station, added to the above value, which represents the constant part for the entire figure. The cost of the transcontinental arc from Cape May to San Francisco was two hundred dollars per linear mile (\$124 per kilometer), three and a half dollars per square mile (\$1.35 per sq. kilo.), and two thousand dollars per station.

A fine example of rapid expansion from the base to a fully developed net of triangulation is found in the vicinity of Salt Lake, and is a characteristic specimen of primary

work as carried out in the Rocky Mountain region of the United States. The average height of the thirteen stations composing the main scheme is 11,256 feet (3,431 meters), while the average length of the lines connecting them is 159,734 kilometers ($99\frac{1}{4}$ miles). The distance between Mt. Ellen and Uncompagre is 294,104 kilometers ($182\frac{1}{2}$ miles). This remains to the present day the longest line observed from both ends and forming an integral part of a regular system of triangulation executed by any trigonometric survey in existence. Indeed, the entire chain from the Sierra Nevada on the west to the Mississippi plateau on the east is without a parallel in similar work, when we consider the magnitude of the geometrical figures, the elevation of the stations and the refinement of the individual measures.

Referring to a part of this work—the base net at Salt Lake, Utah—the following details are of interest:

The elevation of the base above sea level is about 4,224 feet, while the mean height of the stations composing the quadrilateral is 11,088 feet. In only five steps we pass from a base 11.2 kilometers in length to a line 237,765 kilometers long (Pilot Peak, Mt. Nebo). This involves an average multiplication of $4\frac{1}{4}$ times for each step of expansion, which is within the limit set for development in well conditioned triangulation. The resulting quadrilateral in which the base line expansion culminates and on which the transcontinental extension rests contains nearly 10,500 square miles and is the largest yet realized. The base net including this figure (Ogden, Mt. Nebo, Ibepah and Pilot) was adjusted separately and brought out the following criteria of accuracy:

FROM STATION ADJUSTMENT.

Average probable error of a single observation of a direction.....	$= 0''.71$
Average probable error of an adjusted direction.....	$= 0.10$

FROM FIGURE ADJUSTMENT.

The largest correction is.....0".84
And 55 per cent. of the corrections are less than...0.25

The probable error of the side Ibepah-Nebo, depending on angular measures only, is 1/280,000 of its length.

Heliotropes were continually employed, and the angles were measured with a theodolite having a horizontal circle of 20" diameter and a magnifying power of 83.

ASTRONOMICAL WORK.

Aside from the work in practical astronomy incident and necessary to the operations of every trigonometrical survey, attention has been given to various other phases of the subject. It has not alone sufficed to point out and demonstrate the utility of the method of equal zenith distances for latitude, and of the application of the telegraph to longitudes. The Coast and Geodetic Survey feeling the necessity of better star places, arising from the use of the methods just mentioned, has devoted some of its energy to the perfection of star catalogues. It is probably no exaggeration to say that the declinations given in our field lists are the best attainable anywhere. More than fifty of the best modern catalogues are corrected for their systematic errors, and each is given weight depending on the value of the work and number of observations. A collection of all these data, and their consolidation into one homogeneous result, eliminates as far as possible all known sources of inaccuracy, and gives us finally the most reliable positions. A list so constructed of several thousand stars has been already published, many of which are especially adapted to southern work. The average probable error of a declination may be given as rather less than $\frac{1}{4}$ of a second; a degree of precision, which enables an observer to determine his latitude from 20 pairs, in one evening, with an uncertainty of only ± 10 feet. This is sufficient for the

purposes of geodesy. Incidental to regular astronomic work, the Survey has equipped and sent out no less than 35 parties for the observation of solar eclipses and transits of the inferior planets, which work has required the occupation of stations in every continent and Polynesia. The variations of latitude have been determined at three stations, each one having been occupied more than a year.

MISCELLANEOUS OPERATIONS.

The legitimate field of investigation in a geodetic service embraces many subjects outside of those already specified. In the execution of the task before us a free interpretation has been given to the law authorizing the work, and the kindred subjects of Hypsometry, Magnetism, Gravity and Physical Hydrography have been pursued along with others more strictly within our province.

Five thousand miles (8,047 kilometers) of precise levelling have been executed, including four independent determinations of the height of St. Louis. Two have been made from the Atlantic at Sandy Hook, and two from the Gulf of Mexico at Biloxi.

A comparison indicates that the surface of the Gulf is somewhat higher than the sea level at New York, and this has been verified in character, although not precisely in amount, by a line across the peninsula of Florida, three times repeated. Other subsidiary lines have been observed. The limit of error has been that usually adopted in similar work, viz., 5 mm. \sqrt{K} . The heights by spirit level have been supplemented and controlled by micrometric measurements of zenith distances. In the determination of elevations necessary to reduce the base lines along the transcontinental arc to sea level the latter method has been employed across the Allegheny and Rocky Mountains. The spirit levels are continuous from Sandy Hook to Denver and Colorado Springs.

They are checked by zenith distances from the Chesapeake Bay to the Ohio River, and supplemented by the same method from Denver to the Pacific coast, where the spirit levels are not yet completed.

Permanent magnetic observations have been in operation at Philadelphia, Key West, Madison, Los Angeles, and each one has furnished records for five consecutive years; with one exception a self-registering apparatus has been continuously and exclusively employed in each locality. These data added to records from 1,100 widely distant points, many of which are secular variation stations, furnish precious material for the study of the earth's magnetism. The work of the Survey in the investigation of the force of gravity has been carried on both within and without the limits of the United States. Twenty-eight foreign stations have been occupied, including points in Europe, Asia, Africa, Australia and many islands in both the Atlantic and Pacific. New light on the subject of volcanic formation, as well as on the constitution of the earth's crust, has come from this work. Fifty nine-stations have been observed at home, including a line across the continent. Half-second pendulums are now exclusively employed, and the determinations are purely differential. The period of oscillation is usually known to within a few millionths of a second.

In the field of Physical Hydrography most comprehensive studies have been made.

The exploration of the Gulf Stream, including a study of its density, temperature and currents, the geology of the sea bottom, the establishment of cotidal lines, the determination of the ocean depth from earthquake waves and other specialties in the domain of hydrography, have been made a part of the regular work. The hydrography of the coast, to the head of tide-

water, has been developed side by side with the triangulation and topography.

The practical results of the Survey are shown in the publication of the annual reports, the issue of charts, notice to mariners (corrected monthly), coast pilots for Atlantic, Pacific and Alaskan waters, tide tables (now extended to foreign ports) and various miscellaneous publications in special lines of research.

PRESENT AND FUTURE OPERATIONS.

A resurvey of Chesapeake Bay, the measurement of an arc through the United States on the 98th meridian, and the development of Alaskan geography, are among the projects of Dr. Pritchett, the present superintendent of the organization. All these have been carried on during the last two years. The line of transcontinental precise levels is being pushed westward with all available means. Primary triangulation on the Pacific coast has been resumed, and will soon be completed from San Francisco to the Mexican boundary. Hydrographic surveys are in progress along the Atlantic seaboard, on the Pacific, and at the mouth of the Yukon in Alaska. Numerous topographic, astronomic and magnetic parties, are employed in the interior.

An extension of the great arcs of the United States into Mexico and the British possessions has been proposed by Dr. Pritchett, and diplomatic representations between the interested governments looking towards concerted action in the near future have already been made. This will give to North America an additional meridian arc of about 55° and an oblique one of 33° . Together with existing arcs, the proposed material will practically exhaust our contribution to the determination of the earth's figure.

In the ordinary prosecution of the field work since 1895 about fifty parties have been employed during the course of each

year. Added to this, the purely hydrographic work has been carried on by a fleet of sixteen vessels, of which ten are steamers. The operations have been widely distributed, extending as far as the Pribilof Islands in the Bering Sea. A longitude determination was made from Sitka, of Kadiak and Unalaska, in which twenty-one chronometers were carried on four successive trips. The probable error of the resulting longitudes was 0'.20 for the former and 0'.21 for the latter. A tidal indicator, similar to the one in New York, has been erected at Philadelphia, and one is in process of construction at San Francisco. The mechanism, actuated by the tide, furnishes the navigator at any moment, at a distance of one mile, with necessary information as to the character and amount of the tide.

Among the auxiliary duties of the service may be mentioned the establishment of trial speed courses for ships of the Navy (a number of which have been recently laid out); the exploration of oyster beds; the fauna of the Gulf Stream; the administration of an Office of Standard Weights and Measures, from which prototypes are issued to the different States; meteorological researches for the use of the coast pilot; the study of astronomical refraction; mathematical investigations on the theory of projections, on the equations of steady motion, on errors of observations; and finally, in experimental researches in engraving, electrotyping and lithography; all of which knowledge finds application in the various fields of activity now covered by the Coast and Geodetic Survey.

WORK OF THE UNITED STATES ENGINEERS.

Geodetic surveys have also been carried on by the Corps of Engineers of the United States Army. That of the Great Lakes was completed in 1882. The work was reorganized in 1892, and resurveys and exten-

sions thereto are now in progress. Changes in the original plan have been introduced, chiefly in the direction of rapidity of execution. Fewer positions on the circle are now used for horizontal angles, and adjustment is effected by separate small figures, rather than through any extended scheme. In the measure of the Mackinaw base three tapes were used, each a kilometer in length. Each section of the tape was compared with a standard length of 100 meters established on the ground. This standard length was determined by means of an 8-meter bar packed in ice, which in turn was compared with the Repsold meter, R 1878.

The Engineer Corps of the Army has also had charge of the Mexican boundary survey, and of the work done by the Missouri and Mississippi River Commissions. The report on the Mexican boundary is already in type, but is not ready for distribution.

The Missouri River Commission has completed a triangulation from St. Louis to Three Forks, in Montana, a distance of 2,551 miles. The work follows the river and covers the valley from bluff to bluff. Precise levels have been run over 807 miles of it, and ordinary levels cover the remainder. Ten base lines have been measured with a standardized steel tape.

The Mississippi River Commission, utilizing some work already done by the Lake Survey and the Coast and Geodetic Survey, has now a complete connection from the Gulf of Mexico to St. Paul, in Minnesota. The total distance is about 1,600 miles. Twenty-seven bases have been used, of which eighteen have been measured by the Commission with a steel tape 300 feet long. The work has been adjusted by quadrilaterals employing the method of least squares.

E. D. PRESTON.

EXECUTIVE OFFICER TO SUPERINTENDENT
U. S. COAST AND GEODETIC SURVEY.

THE AMERICAN MORPHOLOGICAL SOCIETY.

I.

THE ninth meeting of the Society was held at Columbia University, New York City, on December 28th, 29th and 30th. Professor H. F. Osborn was in the chair; Dr. G. H. Parker, Secretary. In the course of his introductory remarks, Professor Osborn welcomed the Morphologists to the new zoological laboratories at Columbia, and especially congratulated the Society upon the rapid progress which morphology in all its branches is making in this country. He spoke of the important part which had been played by the *Journal of Morphology* during the past eleven years, and the debt owed by American zoologists to Mr. Allis for his generous support. This journal now requires for its maintenance the financial support of all morphologists of this country, all of whom should assist by subscribing. One of the marked features of recent progress is the rapid development of fresh-water and marine biological stations, all of which are contributing to our detailed knowledge of American fauna, and in some cases extending even to the study of important foreign types. The greatest defect in recent work is the tendency to prolixity. 'Brevity is the soul of wit,' and the very expansion of zoological literature necessitates as condensed a style of writing as is consistent with completeness and clearness. The recently collected papers of Huxley prove that it is possible to present the most important results in very condensed form.

In the business session the following are the more important transactions: A resolution expressing the grateful acknowledgments of the Society to Mr. Edward Phelps Allis, Jr., for his munificent gifts towards the founding and maintenance of the *Journal of Morphology* during the first ten years of its existence; the election to membership of F. W. Bancroft, C. L. Bristol, G. N. Calkins, J. J. Hamaker, Samuel Henshaw, C.

F. W. McClure, C. B. Wilson and M. A. Wilcox; and the election of officers: President, E. G. Conklin; Vice-President, W. M. Wheeler; Secretary and Treasurer, Bashford Dean; Executive Committee, J. P. McMurrich and G. H. Parker.

Forty-five papers were presented before the scientific sessions, of which the greater number are here given in summary in the order in which they were read.

Notes on the Development of a Myxinioid.

BASHFORD DEAN.

PARTICULAR reference was made to the horn-like egg membrane as maternal in origin; it is traversed by pore-canals analogous to those of the radiata of teleostomes. The anchor filaments represent the greatly specialized end-bulbs of the radial elements of the shell. Early segmentation is confined to a small but definite hillock of germinal protoplasm subjacent to the micropylar canal. In early blastula stages the cell cap extends downward to the region of the opercular ring. Gastrulation is noted when a downgrowth takes place on one side; here the head of the embryo shortly appears, and the trunk is laid down longitudinally as the blastoderm progresses, now symmetrically, toward the vegetative pole. Neural folds are early apparent, and the brain is tubular and relatively of great length. In some cases the tail buds out when the downgrowth of the blastoderm has enveloped scarcely more than the anterior half of the egg. In others the outgrowth of the tail is notably retarded. A primitive streak is present, terminating behind in an ovate yolk plug; the latter is latest apparent near the vegetative pole. There is no evidence of a greater number of gill slits than the normal number.

On the Reproductive Habits and Development of the Californian Land Salamander, Autodax.

W. E. RITTER. (Presented by G. H. Parker.)

THE subterranean egg-burrow of this saltatory urodeles resembles somewhat closely that of *Ichthyophis*. The eggs are retained in a cluster and attended and kept moistened, probably with urine, by the female. A series of embryos taken from a single burrow will shortly be described.

New Facts regarding the Development of the Olfactory Nerve. W. A. LOOY.

THE early embryonic history of the olfactory nerve is known. There has been little advance in this direction since the appearance of Marshall's paper in 1878, who gave the history of the nerve prior to the formation of the lobe and anticipated by suggestion most of the views since expressed regarding its nature and relationships. The chief advances have been made in determining the source of the fibers (His, Disse and others), and in the minute structure of the olfactory lobe, ganglion, etc. (Cajal, Retzius and others). But, in the meantime, the early embryonic history has not been elucidated, and, even to-day, we do not possess the complete history of this nerve in any one animal.

This paper presented in outline the history of the olfactory nerve in *Acanthias* from its earliest appearance to adult conditions, embracing (a) the embryonic history of the olfactory nerve prior to the formation of the lobe, and (b) the formation of the olfactory lobe, its various transformations, and the subsequent history of the nerve. The chief point of interest consists in demonstrating a hitherto unrecognized olfactory nerve, and determining its history and relationships to the olfactory bundle. The new nerve arises from the summit of the forebrain near the median plane, and passes laterally into communication with the main olfactory and thence into the olfactory cup. It is the first one to appear and may, therefore, be primitive. It is ganglionated. It was discovered by dissections of very small

embryos—it lies in such a position that its relationships would not be appreciated by study of sections made in any of the conventional planes.

There are two distinct, widely separated connections existing simultaneously between the olfactory epithelium and the brain-wall, one is dorsal and median (the new nerve) and the other is lateral. The latter is complex, consisting of two main divisions. The new nerve can be demonstrated in specimens, as early as 6–8 mm. in length. The two brain connections are well seen in embryos 16 mm. and upwards; they are very evident from 20mm. forwards. The lobe begins in specimens about 25mm. long; it is still small at 38mm., but well developed at 44 mm. and upwards. The fibers of the new nerve were traced into the olfactory epithelium. It was also shown to perish in the adult.

Review of Recent Evidence on the Segmentation of the Primitive Vertebrate Brain. W. A. LOOY. (Read by title.)

The Metameric Value of the Sensory Components of the Cranial Nerves. C. JUDSON HERRICK.

THE primary segmental or branchiomic nerve is conceived as comprising four components: somatic motor, visceromotor, somatic sensory (general cutaneous) and viscerosensory (communis). No cranial nerve of any gnathostome vertebrate has retained all these components.

In the head each sensory component, as a physiological adaptation, has been concentrated so that all its fibers tend to be related to a single center in the brain—the fasciculus communis (f. solitarius) and chief vagus nucleus in the case of the visceral sensory and the spinal fifth tract and related nuclei, chief sensory trigeminal n. and n. funiculi, in the case of the somatic sensory. This involves reduction of each component in some segments and hyper-

trophy in others. Thus, the somatic sensory is represented only in the V and X nerves and the visceral sensory in the typical branchiomeric nerves, X, IX, VII.

Now when in course of vertebrate evolution specialized sense organs appear in addition to the two primary components, their nerves and intra-cranial centers will appear sporadically, depending upon the distribution of the specialized sense organs in question. These nerves will in general follow the courses of the previously existing somatic or visceral nerve trunks wherever possible, hence the formation of complex nerve trunks containing several of the components. Each of these cenogenetic systems of sense organs, like the palingenetic systems, tends to be related to a single intra-cranial center. At present we may enumerate the following such systems:

1. Taste buds related to the fasciculus communis (f. solitarius) and its associated nuclei, the chief vagus nucleus (lobus vagi of fishes).
2. Terminal buds of the outer skin; terminal relations as in the last case, plus in some fishes the lobus facialis.
3. Lateral line organs, or neuromasts, related to the tuberculum acusticum and cerebellum, plus in some fishes the 'lobus lineæ lateralis.'
4. Ear; central connection as in the last case.
5. Eye; related to the mesencephalon.
6. Nose; related to the primary prosencephalon.
7. Pineal organ; related to the dien-cephalon?

Diagrams were exhibited illustrating the actual relations of these components as determined by reconstruction from serial sections in the bony fish, *Menidia*; and emphasis was laid upon the necessity of taking these qualitative differences in the nerves into account before trying to work out their metamerism.

The Maxillary and Mandibular Breathing Valves of Teleost Fishes. ULRIC DAHLGREN.

THE discovery of a pair of membranous valves placed just inside of the teeth and working automatically to prevent water from leaving by the mouth while they permit its free entrance, has enabled the act of breathing in fishes to be clearly described. These valves complete the pump-like structure of the oral cavity, the other pair, or posterior valves, being the branchiostegal membranes.

In breathing, but two muscular forces must be applied, one to expand the oral cavity by moving the opercular frames outward and another to contract the oral cavity by moving them inward; when expanding, water comes in through the mouth, being prevented from entering through the gill clefts by the branchiostegal membranes, which act *automatically* and independently of and contrary to the opercular frames to which they are attached; when contracting, water is forced out of the gill clefts, but is prevented from leaving through the mouth by the valves in question, which act *automatically*. While breathing, it is true, the fish opens and shuts its mouth somewhat, but this is due not to its effort to prevent a regurgitation of the respiratory stream, but to the relation of its mandible to the opercular frames.

When the valves are cut, the fish is compelled to use muscular force to prevent regurgitation.

On the Early Development of the Catfish (Noturus). F. B. SUMNER.

1. No horizontal cleavage takes place till the 64-cell stage or after, and, when it occurs, does not result in a definite two-layered condition of whole germ-disc.

2. The blastomeres resulting from the early cleavages retain their continuity with the protoplasmic network of the yolk. No sharp line of separation, such as Sobotta,

Behrens and Samassa describe for the Salmonidæ, exists in the egg of the catfish.

3. After horizontal cleavage occurs, the lower cells resulting from this division retain their continuity with the yolk, as has been described by Kowalewski, Hoffman and Berent (Teleosts) and Dean (Ganoids). These partial cells (merocytes) continue to divide by mitosis both horizontally and vertically. In the former case, the upper of the products of division is added to the germ-disc. This process of supplementary cleavage continues until a late segmentation stage, cells being added to the whole lower surface of the germ-disc.

4. The periblast arises from the residual portion of the merocytes after supplementary cleavage has ceased, being thicker under the margin of the germ-disc, but present elsewhere from the beginning.

5. The periblast is trophic in its function, playing only an indirect part in cell-formation. Normal mitosis soon gives place to abnormal and this in turn to amitosis. Transitional forms occur.

6. The subgerminal space (segmentation cavity) does not appear till about time of origin of germ-ring. At close of segmentation, yolk and blastodisc are in close contact in well-preserved specimens, although no longer continuous with one another. Clefts which early appear between blastomeres or below them are probably artifacts. If not, they disappear later.

7. The germ-ring (mesentoderm) arises primarily as a marginal ingrowth due to cell-proliferation from germ-wall (Randwulst). The germ-ring also receives abundant additions from the overlying primary germ-layer, even at considerable distance from the periphery. (See Reinhard, Arch. f. Mikr. Anat., 1898.)

8. The whole germ-ring, extra-embryonic as well as embryonic, contains both entodermal and mesodermal elements (*contra* H. V. Wilson and Samassa).

9. Kupffer's vesicle arises, as in the Salmonidæ, as a cavity completely shut in by cells from the first. It is at first much compressed horizontally and distinctly bilobed. In embryos with a short tail it is still to be seen near tip of the latter, strongly suggesting neurenteric canal of Selachii. A second vesicle, situated in yolk under the posterior end of the embryo, appears slightly in advance of Kupffer's vesicle and reaches a size exceeding the latter. It is bounded by periblast and perhaps contains more fluid yolk for service of the growing end of embryo.

Respiratory and Breeding Habits of Polypterus Bichir. N. R. HARRINGTON.

ON physiological grounds *Polypterus* is as fully qualified for a 'lung-fish' as are any of the Dipnoans; it has also striking resemblances in its circulatory and respiratory system to the *Urodela*. These points were demonstrated by means of mounted preparations, the injecting of which had been done in the field principally by Dr. Reid Hunt.

Beside the blood-supply to the lungs (which is from the last branchial arch), the dissections showed the very large *glottis*, or ductus pneumaticus, by which the lungs open ventrally from the œsophagus. Unlike the swimming-bladder of fishes in another respect, both the lungs are entirely invested with peritoneum, although one of them, the right, does occupy the normal position for an air-bladder, viz., between the aorta and kidneys, on the one hand, and the alimentary canal, on the other. The mesentery, however, in which the left lobe should be suspended, has almost entirely degenerated, and this somewhat smaller lobe lies entirely free in the body-cavity.

It was pointed out that, while the strongest disproof of the Dipnoan ancestry of the Amphibia lies in the paleontological evidence which indicates that they are a parallel line, the same conclusion may be in-

ferred from the life habits of a form which encysts during periods of drought. For the ability to undergo suspended animation necessitates such specialization that it is improbable that evolution operated through such an encysting form (which is absolutely helpless and inactive until it is set free into the water), in bringing about a vertebrate which breathed air the year around.

Reference was also made to the breeding habits of *Polypterus*, and an accessory copulatory organ in the male—a modified anal fin—was described. The breeding season follows the inundation of the Nile.

The general collections, some of which were exhibited, brought back by the Senff zoological expedition, are intended for general distribution to qualified investigators, who can work up the material within a reasonably short time. Aside from a large collection of Nile fishes, there is material preserved for researches in embryology, electric organs, pseudo-electric organs, neurology and Plankton.

The Coronary Vessels in the Hearts of Fishes.

G. H. PARKER and F. K. DAVIS.

THE muscular substance of the heart in mammals receives its blood from a pair of coronary arteries which connect with coronary veins opening into the right auricle. The inner surfaces of the four chambers of the mammalian heart have upon them openings which lead into vessels connecting with the coronary capillaries, and especially with the veins. These vessels are the veins of *Thebesius*. Is there a similar system of vessels in fishes? Coronary arteries were identified in the common skate, the sand shark and the mudfish (*Amia*). In the skate they may come from various combinations of the efferent branchial arteries of the second to the fifth gill cleft; in the sand shark, from combinations reaching from the first to the fifth

clefts; in the mudfish, from the second branchial arch. In these three species coronary veins occur, all of which open into the venous sinus. On inflating these, bubbling was observed from the natural inner surfaces of the auricles and sometimes from those of the ventricles. These fishes, therefore, have veins of *Thebesius*.

Longitudinal Fission in Metridium marginatum. G. H. PARKER.

TEN animals with double mouths were studied. Two had each two mouths on one oral disc, and the pedal ends of their cesophageal tubes were united. Eight had each completely separate oral discs and cesophageal tubes. In six the mouths were monoglyphic; in three one mouth was monoglyphic and one diglyphic, and in one one mouth was monoglyphic and one aglyphic. There were about twice as many pairs of complete mesenteries as in single mouthed individuals. Double specimens are not the result of fusion, for the two partial individuals are strikingly similar in color, etc., a condition unlikely of occurrence in chance combinations of so variable a species. They may be monstrosities or dividing animals. One specimen nearly divided was kept under observation two months, but showed no advance in the process. In good collecting localities isolated pairs agreeing in color, marking and sex may be found. This evidence favors the view that *M. marginatum* reproduces, by longitudinal fission, a process slowly accomplished, but it does not exclude the possibility of some double specimens being monstrosities.

Additional Characters of Diplodocus. HENRY F. OSBOEN.

THIS is one of the three types of herbivorous Sauropoda or Cetiosauria, represented by a very considerable portion of the skeleton of one individual found by Barnum Brown and the writer in 1897. The scapula, ilium, ischium and femur are associated with

a remarkable vertebral series extending from the 5th dorsal to the end of the tail: (1) The center of motion is the sacrum, where three vertebræ are completely coalesced to the summits of the spines, besides a fourth rib-bearing sacral with a free spine. The sacro-iliac union is by means of both ribs and neuropophysial plates. The presence of such plates in all the anterior caudals, as first described by the writer, proves that the sacrum is reenforced by additions from the anterior caudals. (2) There are more than thirty caudals and three distinct types of chevron, instead of the single type to which Marsh applied the generic name *Diplodocus*. The tail was undoubtedly a powerful swimming organ and also a lever by means of which the anterior portion of the body was elevated, the acetabulum serving as a fulcrum, while the trunk was immersed in water. This power did not exist upon land as in the *Iguanodontia*.

The Ossicula Auditus of the Mammalia. J. S. KINGSLEY and W. H. RUDDICH.

STUDIES on embryo pigs and rats show that the incus is the quadrate, the malleus, the proximal end of Meckel's cartilage. These cannot be homologized with the columellar chain of *Sauropsida*, since they are in front of the spiracular cleft and in front of the chorda tympani, while the columella is behind the spiracle and chorda tympani. The incus (quadrate) articulates with the stapes in the mammals, exactly as is the case in the urodeles. Nothing similar occurs in the *Sauropsida*. This is regarded as additional evidence that the mammals have had an amphibian ancestry. The quadrate cannot have disappeared in the glenoid fossa, as maintained by Albrecht and Cope, as this would involve a translation of parts impossible to explain. The mammalian lower jaw articulates by means of the dentary

rather than by means of the articular, i. e., its articulation is not homologous with that in lower groups. A longer summary of the paper will appear in the *American Naturalist* for March.

Notes on Mammalian Embryology. C. S. MINOT. (Read by title.)

Professor O. van der Stricht's Researches on the Human Ovum. C. S. MINOT. (Read by title.)

Notes on the Morphology of the Chick Brain. S. P. GAGE.

A Specific Case of the Elimination of the Unfit. H. C. BUMPUS.

THE results of a comparative study of one hundred and thirty-six English sparrows, which were rendered helpless or actually perished during the severe storm of February last, was numerically expressed, and it was shown that there was not only a measurable but a striking physical difference between the birds which actually succumbed and those which survived the storm. The birds which perished were longer, heavier, possessed of shorter heads, shorter leg bones, of less breadth of skull and of reduced sternum, while those which survived tended toward the possession of characters opposite to these.

While these average differences between the two groups of birds were emphasized, attention was also called to the fact that the individuals of extreme variability occurred most frequently among the birds which perished. The longest bird and the shortest bird in the entire collection perished. The same is true of the one having the greatest and the one having the least alar extent. The heaviest bird died; the one with the longest and the one with the shortest head died, and the one with the shortest humerus, the one with the longest femur, the one with the longest and the one with the shortest skull, and the one with the shortest keel to

its sternum—all died. The average oscillation of variation around an ideal mean was also shown to be almost invariably in excess for the birds which perished, and the conclusions arrived at were as follows:

The birds which perished were not simply accidental sufferers from the severity of the storm, but were birds which were physically disqualified for enduring the intensity of the New England climate, as expressed by the storm of February 1st, and they were consequently eliminated by natural agents. The result of this elimination produced in this particular locality a colony of birds measurably different from those existing before the storm, that is, the action of natural selection resulted in the elimination of the unfit and the survival of the fit.

On the Anatomy of the Spermatozoon of Invertebrates. G. W. FIELD. (With demonstration of the apical body.)

THE widest diversity in the form of the spermatozoon is found among the different groups of the invertebrated animals. Closer examination shows that there is, however, one type of form which obtains in by far the greater majority of species, and that the aberrant forms are peculiar to those species which have either become parasitic, *e. g.*, certain worms and arthropods, or which have acquired specially modified secondary sexual organs, *e. g.*, lobster, crayfish, *Limulus*.

The common type is the familiar tailed form, prevalent one in the groups Coelenterata, Vermes, Echinoderma, Mollusca, Arthropoda and Tunicata. The three general divisions are usually distinct and readily recognizable. Rarely the spermatozoa of all the species studied have a special structure or apical body at the anterior tip of the head. It has been variously described as (1) an adaptation for boring into the egg; (2) a remnant of the cytoplasm; (3) fluid expressed from the nucleus upon

shrivelling; (4) a micropore surrounded by 'Ringkörper;' (5) an apical button present in the unripe spermatozoon; (6) the sperm centrosome. The first five opinions seem to have little importance when considered in connection with the origin of this apical body. While the opinion of myself and others that it is the sperm centrosome is refuted by the weight of evidence that the sperm centrosome comes from the middle piece of the spermatozoon, yet, so far as I know, the function of this apical body has not been noted by any of those who have studied so successfully the fertilization process. Since it has the same microchemical reactions and the same origin as the middle piece, it would appear as if its fate must be of considerable consequence. I have found this apical body in more than forty species, representing all the groups from the Coelenterates to Amphioxus (including Toxopneustes). By others it has been found in upwards of twenty additional species.

The fact that the apical body is present in the spermatozoon of well-nigh every species studied indicates that it has some very special significance which should not be overlooked by workers on the phenomena of fertilization.

The Middle Piece of the Urodele Spermatozoon. J. H. MCGREGOR. (Read by title.)

The Origin of the Yolk in the Egg of Molgula.

HENRY E. CRAMPTON, JR.

THE author presented the principal results of an extended study upon the early history of the ascidian oöcyte, considered from a chemical as well as from a purely morphological aspect, made by means of carefully controlled aniline staining supported by artificial digestion and other tests. It was found that the cell-body at the beginning of enlargement of the primary oöcyte presents no albumen reaction. There is, however, a small albuminous gran-

ular body formed just outside the nucleus, which enlarges by the addition of granules similar to those found in the nucleus, until it becomes first a cap-shaped mass and finally surrounds the nucleus. *1st Period: Formation of the 'yolk-mass.'* This body then disintegrates, the constituent granules being spread evenly throughout the now highly vacuolated cell-body. The latter was shown to be composed probably of a pseudo-nuclein. *2d Period: Disintegration of the yolk-mass.* The ovum assumes its final character by the progressive vacuolization of the cell-body, and by the enlargement of the products of disintegration of the 'yolk-mass' to form the definite 'deutoplasm' spheres. *3d Period:* The original was considered to be of nuclear origin, and is probably what has been loosely homologized in some cases with the 'corpus vitellin de Balbiani,' etc.

Protoplasmic Movement as a Factor of Differentiation. EDWIN G. CONKLIN.

VARIOUS factors have been suggested by different persons as the causes of differentiation, but so far no one has shown that the active movements of protoplasm constitute such a factor.

The polarity of the egg and the specializations of cleavage are two of the earliest differentiations of the developing organism. In the gasteropod *Crepidula* both of these differentiations are associated with definite and orderly movements of the protoplasm.

Before the maturation the germinal vesicle lies near the center of the egg and the yolk is uniformly distributed. With the appearance of the centrosomes and the formation of the first maturation spindle the nuclear membrane is broken opposite the poles of the spindle, nuclear sap escapes into the cell and at the same time the nucleus, spindle and surrounding cytoplasm are carried bodily toward the surface of the egg. Coincidentally with this migration of the

nuclear constituents there is a segregation of the cytoplasm at one pole (the animal) and of yolk at the other (the vegetal). This separation of yolk and cytoplasm goes on during the second maturation division and throughout all the stages of fertilization. The movements of the germinal vesicle and of the maturation spindles, the separation of yolk and cytoplasm and also the approach of the pronuclei during fertilization seem to be due to protoplasmic currents.

In the cleavage of the egg the evidence for such currents is much more abundant and complete. Centrosomes and *Zwischenkörpern* are preserved throughout the resting period following division, and by means of the relative positions of these bodies at different stages, as well as the relative positions of the nuclei, yolk and cytoplasm, the direction and extent of these movements can be accurately determined. During the anaphase of the first cleavage the spindle lies at right angles to the egg axis, and the centrosomes, chromatic plates and *Zwischenkörper* are in a straight line. In later stages the *Zwischenkörper* is carried down to the center of the egg, the centrosomes are carried up to the surface and move toward each other until they come to lie on each side of the first cleavage plane and immediately under the polar bodies; the nuclei are also moved upward and toward each other until they are almost in contact on opposite sides of the first cleavage wall, and the cytoplasm moves down into the center of the egg, the yolk at the same time moving up at the periphery. Such movements could be caused only by vortical currents in the daughter cells moving up at the surface and down through the center of the egg; the cell wall forms where these opposite currents meet.

Similar vortical currents occur in every cleavage up to a late stage, and they offer most important evidence not only as to the mechanics of cleavage, but also as to the me-

chanics of differentiation. Of the four commonly recognized features of differential cleavage—viz.: (1) inequality, (2) non-alternation of directions, (3) qualitative differentiation and (4) lack of rhythm—the first three may be correlated with these movements. Unequal cleavages are due to movements which, beginning with the early anaphase, carry the nucleus out of the center of the cell. Non-alternation is due to the absence of currents, alternation to the regular reversal of currents during each successive division. Certain qualitative differences of the two daughter cells of every cleavage are also due to these movements. The remains of the centrosphere (idiosome of Meves, mother periplast of Vejdovski) in each blastomere is carried by definite rotations of the protoplasm into one only of the two daughter cells into which the blastomere divides; there is thus produced by protoplasmic movement a visible qualitative difference in the two daughter cells formed at every division.

The Characteristics of Mitosis and Amitosis. S. WATASÉ.

On Hæmatococcus. F. H. HERRICK.

OBSERVATIONS ON *Hæmatococcus* began with Girod-Chantrons in 1797 and have been continued during the present century by Agardh, Cohn, Braun, Rostafinski, Bütschli and others. The chief points of contention lie in the supposed sexual character of this organism and in the structure and functions of the zoospores.

The following summary of results was presented: (1) Resting cells after long submergence in water lose the power of development. In one case, after being submerged for two years, the cells have greatly thickened walls, but no zoospores are formed. If these cells are now dried, even for a short time, and then returned to water development rapidly follows. *Hæmatococcus* has thus become adapted to the alternation of

drought and moisture, so that desiccation or something equivalent to this has become necessary to bring about a normal response. (2) Great variation not only occurs in the form and size of the sporangium (developing mother cell wall) and in the number of the zoospores, but in the size of the zoospores produced in the same sporangium. In respect to size at least the terms 'macrozoospore' and 'microzoospore' have no significance. (3) The zoospores imbibe water after liberation and undergo marked changes in appearance. Before maintaining that all zoospores have a similar structure, it may be necessary to repeat and extend certain experiments, but we are convinced that no sexuality can be attributed to this form, and that no true copulation has ever been observed. (4) Monstrosities frequently occur in the motile stage, such as twins and cells with four or more 'heads' (pairs of flagella) in all cases due not to *fusion*, but to incomplete division of the mother cell. (5) Reproduction by internal cell division has been observed in the motile stage in a few cases, in one of which the zoospore-colony consisted of four small cells freely moving in the sac of the mother zoospore, which was itself distinctly propelled by its own cilia. The mother capsule soon burst setting the young free. (6) When a motile cell comes to rest its protoplasmic sac contracts and a spherical resting cell is formed which secretes its proper wall while still enclosed in the evanescent wall of the zoospore. The flagella break at the 'beak,' leaving two slender rods united with the wall of the metamorphosed zoospore. These are probably elastic cellulose tubes which serve to sustain the flagella at the points where they pierce the sac. (7) In the course of zoospore-formation in large cells endosmosis is very great and the surface tension of the wall unequal. The transparent sphere is blown out in a form often resembling that of an incandescent light bulb, with abundant room for the

active cells. The wall at the small end of the bulb is still very thick, and at the moment of bursting suddenly contracts and scatters the zoospores with a rush. (8) Under various conditions direct development of resting cell from resting cell seems to occur. This looks like a process of arrested development of zoospores, in which cell division is complete, but the characteristics of the motile cell do not appear.

BASHFORD DEAN,
Secretary.

COLUMBIA UNIVERSITY.

(To be concluded.)

ASSOCIATION OF AMERICAN ANATOMISTS.

THE eleventh annual session was held in New York City, December 28th-30th, in conjunction with the 'Naturalists' and other affiliated societies. Most of the meetings were held at the Medical Department of Columbia University. Forty-one members attended and 20 new members joined, making a total of 141, of whom 10 are honorary. The localities and names of the new members are as follows: From Ann Arbor, Professor J. P. McMurrich, University of Michigan; from Baltimore, Professors F. P. Mall and L. F. Barker and associate R. G. Harrison, of the Johns Hopkins University; from Buffalo, Dr. N. S. Russell, assistant in anatomy, University of Buffalo; from Ithaca, Dr. L. Coville, lecturer and demonstrator in anatomy, Cornell University Medical College; from Montreal, Dr. J. G. MacCarthy, senior demonstrator of anatomy, McGill University; from New York City, Professor J. D. Erdmann, of Bellevue Medical College; Dr. Evelyn Garrigues, assistant demonstrator of anatomy, Woman's Medical College; Dr. Ales Hrdlicka, associate in anthropology, Pathological Institute of New York Hospitals; and the following assistant demonstrators of anatomy in Columbia University: Doctors G. E. Brewer, C. Carmalt, H. D. Collins, G. W.

Crary, W. Martin, W. H. Rockwell and A. S. Vosburgh; from Philadelphia, Professor J. C. Heisler, of the Medico-Chirurgical College; from Savannah, Dr. E. R. Corson; from Washington, D. C., Dr. C. I. West, demonstrator and lecturer in topographical anatomy, Howard University.

The address of the President, Dr. Burt G. Wilder, discussed, 'Misapprehensions as to the Simplified Nomenclature;' the speaker urged especially a fuller recognition of what had been done by the English anatomists, Barclay, Owen, Pye-Smith and T. Jeffery Parker, and hoped the nomenclature of the future would be called the 'Anglo-American.'

The Association voted that abstracts of papers be required in advance, and that brief abstracts be included in the program; that the time for reading papers be limited to thirty minutes; that the Secretary-Treasurer be allowed his railroad fare and ten dollars toward his hotel expenses at each meeting. The Association also accepted the propositions of the editors of the (English) *Journal of Anatomy and Physiology* as to making that journal the official organ of the Association, and nominated Professor George S. Huntington as the American editor. The details of the arrangement will be given in a circular to be issued by the Secretary of the Association. Dr. E. W. Holmes, of Philadelphia, was elected member of the Executive Committee, and the President was authorized to fill the vacancy in the Committee on Anatomical Nomenclature caused by the resignation of Dr. Dwight.*

The subject assigned for discussion, 'The Teaching of Anatomy in Our Medical Schools,' was opened by Dr. Holmes; 'The Defects of our Present Methods,' and further considered under ten divisions, viz: (1) Preparatory education. (2) The value and place

* Dr. E. C. Spitzka, of New York City, has since been selected.

of General Biology and Comparative Anatomy. (3) Histology and Embryology in the medical course. (4) The relative value of didactic methods. (5) Practical Anatomy and how to teach it. (6) The order of topics. (7) The correlation of structure and function in teaching. (8) The use of charts and blackboards. (9) The qualifications requisite for a teacher of anatomy. (10) The desirability of terminologic consistency; by Dr. Gerrish (4, 6 and 8), by Dr. Huntington (2, 3, 5 and 6), and by Dr. Wilder (10). In view of the extent and importance of the subject it was suggested that at future meetings a smaller number of divisions be more fully considered.

The following papers were read and discussed; all were illustrated by specimens and charts or photographs, and several by lantern-slides or enlarged photographic projections: By J. A. Blake, 'The roof and lateral recesses of the fourth ventricle considered morphologically and embryologically;' by G. E. Brewer, 'Preliminary report on the surgical relations of the duodenal orifice of the common bile-duct;' by E. R. Corson, 'An X-ray study of the normal movements of the carpal bones and wrist;' by F. Dexter, 'Morphology of the digestive tract of the cat;' by T. Dwight, 'The origin of numerical variations of the vertebræ,' and 'The living model showing the platysma in contraction;' by S. H. Gage, 'Further notes on the relation of the ureters and great veins;' by I. S. Haynes, 'An explanation of a new method of cutting gross sections of the cadaver, with demonstration of the technique;' by Ales Hrdlicka, 'The normal human tibia;' by G. S. Huntington, 'Morphology and phylogeny of the vertebrate ileo-colic junction,' 'Visceral and vascular variations in human anatomy,' and 'the sternalis muscle;' by W. Martin, 'The cæcum and appendix in 100 subjects;' by J. J. MacCarthy, 'The internal structure of the hip-

pocampus;' by B. B. Stroud, 'Note on the staining of isolated nerve-cells,' and 'Preliminary account of the degenerations in the central nervous system of frogs deprived of the cerebrum;' by B. G. Wilder, 'Some current misapprehensions as to the objects of the Cornell collection of brains.' For lack of time there were read by title only Dr. Wilder's paper, 'Further tabulation and interpretation of the paroccipital fissure (occipital division of the intraparietal complex);' three papers by Dr. Huntington, 'The genito-urinary system of the American pit-viper,' 'Contribution to the anatomy of the reptilian vascular system,' 'Cerebral fissures and visceral anatomy of the Eskimo from Smith's Sound;' and Dr. Haynes' discussion of teaching.

At its closing session, December 30th, the Association adopted, without dissent, the report of the Committee on Anatomical Nomenclature presented by the majority (Gerrish, Huntington and Wilder). It comprises four divisions, viz:

A. Brief statement of reasons for preferring certain terms (about fifty in number) already adopted by the Association.

B. Recommendation of *mesocelia* as a name for the cavity of the mesencephalon, with reasons therefor.

C. Recommendation of 181 names of bones (120) and muscles (61) identical with those in the B. N. A. (Basel Nomina anatomica).*

D. Recommendation of 17 names of bones and muscles differing from those of the B. N. A.

D. S. LAMB,

Secretary.

* Die anatomische Nomenclatur. Nomina anatomica, Verzeichniss der von der Anatomischen Gesellschaft auf ihrer IX. Versammlung in Basel angenommenen Namen. Eingeleitet und im Einverständniss mit dem Redactionsausschuss erläutert von Wilhelm His. Archiv. für Anatomie und Physiologie. Anat. Abth., Supplement Band, 1895. O, pp. 180; 27 Figs., 2 plates.

AMERICAN MATHEMATICAL SOCIETY.

THE regular meetings of the American Mathematical Society were formerly held at monthly intervals from October to May, the program being readily disposed of in a single afternoon session. A summer meeting, occupying two days, was also held, usually in connection with that of the American Association. At the Buffalo meeting in 1896 and the Boston meeting in 1898 a colloquium, or course of lectures on recent developments in mathematics, was also provided. With the growth of the Society in maturity and productivity it was found advisable about two years ago to modify this plan so far as concerned the winter meetings. In order to make the individual meetings more prominent and to secure them a concentration of interest, it was decided that they should be held at intervals of two months, viz., on the last Saturday of October, February and April, and on a variable day in the last week of December. In compensation for the reduction in the number of meetings, provision was made for two sessions at each meeting, to be held in the morning and afternoon. About the same time the Chicago Section was organized, and its April and December meetings have proved valuable additions to the Society's activities. The results have fully justified the wisdom of the new departure. The attendance has greatly increased, the number of papers presented at each meeting has quadrupled, and the meetings have become more substantial and active centers of mathematical intercourse. This remarkable advance is in one way occasioning the Society a delectable embarrassment. The number of papers offered for presentation is becoming so great that the two sessions of the meetings no longer furnish anything like adequate time for their reading and discussion. It will apparently soon be necessary to provide longer or more frequent meetings, against both of which

suggestions valid objections can be urged. Another consequence of this profusion of mathematical riches is the growing inadequacy of the present facilities for publication of original mathematical articles in the country. The *Bulletin* of the Society was established as a journal of critical and historical investigation, and although, by the publication of a great number of shorter original articles, it has widely departed from its original purpose, it is no longer able to keep pace with the steadily increasing output without sacrificing its proper functions, a course which cannot be permitted. The Council of the Society has, therefore, had for some time under consideration the question of providing better facilities for publication, and is at present seriously contemplating the periodical publication of *Transactions* of the Society. This is a project very near to the hearts of many influential and productive members of the Society, and the enthusiasm which it has aroused has again contributed to stimulate the energies of the Society and affords gratifying evidence that the undertaking will be successfully carried through.

A regular meeting of the Society was held at Columbia University on Saturday, February 25th. The total attendance at the two sessions was forty-seven, including thirty-nine members of the Society. President R. S. Woodward, who has succeeded President Simon Newcomb, occupied the chair. The Council announced the election of the following persons to membership in the Society: Mr. John B. Faught, Bloomington, Ind.; Professor Edward B. Fishburne, Waynesboro', Va.; Professor William P. Graham, Syracuse, N. Y.; Dr. Waldemar Schulz, Ithaca, N. Y.; Dr. Ernest J. Wilczynski, Berkeley, Cal. Four nominations for membership were received. An amendment to the constitution was adopted, by which retiring Presidents of the Society

are retained in the Council for one year after retirement.

The following papers were read at the meeting :

- (1) PROFESSOR M. I. PUPIN : 'Electrical oscillations on a loaded conductor.'
- (2) PROFESSOR MAXIME BÔCHER : 'An elementary proof that Bessel's functions of the zeroth order have an infinite number of real roots.'
- (3) PROFESSOR J. M. PEIRCE : 'Determinants of quaternions.'
- (4) PROFESSOR HENRY TABER : 'The chief theorem of the theory of finite continuous groups.'
- (5) PROFESSOR ALEXANDER MACFARLANE : 'On the imaginarity of geometry.'
- (6) PROFESSOR EDGAR ODELL LOVETT : 'On a certain class of differential invariants.'
- (7) PROFESSOR JAMES PIERPONT : 'On arithmetizing mathematics.'
- (8) DR. VIRGIL SNYDER : 'Lines of curvature on annular surfaces having two spherical directrices.'
- (9) PROFESSOR W. F. OSGOOD : 'On a continuous function of a real variable whose derivative cannot be integrated.'
- (10) PROFESSOR ERNEST W. BROWN : 'On the progress of the calculations in the new lunar theory.'
- (11) PROFESSOR M. I. PUPIN : 'Lagrange's equations and the principle of equality of action.'
- (12) PROFESSOR E. B. VAN VLECK : 'On the determination of a series of Sturm's functions by the computation of a single determinant.'
- (13) DR. G. A. MILLER : 'On the primitive groups of degree 17.'
- (14) DR. L. E. DICKSON : 'Concerning the abelian and hypoabelian groups.'
- (15) DR. F. H. SAFFORD : 'Surfaces of revolution in the theory of Lamé's products.'
- (16) DR. D. F. CAMPBELL : 'On linear differential equations of the third and fourth orders in whose solutions exist certain homogeneous relations.'
- (17) MR. E. R. HEDRICK : 'On three-dimensional determinants.'
- (18) DR. G. H. LING : 'An examination of groups whose orders lie between 1093 and 2000.'

- (19) PROFESSOR A. G. WEBSTER : 'Traces illustrating the motion of the top.'

The next meeting of the Society will be held on Saturday, April 29th. The Chicago Section meets at the University of Chicago on Saturday, April 1st.

F. N. COLE,
Secretary.

THE NOMENCLATURE OF THE HYOID IN BIRDS.

THE hyoid apparatus of birds is so simple a structure, one so long known and so well studied, that it would naturally be supposed anatomists might agree upon the names of its component parts. Those who have occasion to refer to anatomical text-books, however, are well aware that there is a surprising, not to say bewildering, variation in the nomenclature used by different authors, as a glance at the accompanying figure and table of names will make apparent.

It is quite evident that all of these names cannot be correct, and a little reflection will show some of the changes that are certainly needed, and others that probably should be made. Taking the last first, let us consider that part, B, termed urohyal by Mivart and Gadow. The urohyal of fishes is a membrane bone developed beneath the anterior portion of the branchial arches ; hence, it is quite evident that the name cannot be consistently applied to a cartilage bone at the posterior end of the branchial apparatus, and that Parker's term, second basibranchial, should stand. Equally simple is the case of the paired bones, D, called basibranchials by Gadow and hypobranchials by Beddard. Basibranchials are unpaired bones developed in the median line, and the term is inapplicable to paired bones lying on either side of an unpaired basal bone. As for hypobranchials, these are among the first seg-

ments of a branchial arch to disappear, not being developed even in tailed amphibians, and it will be safe to call the lower portion of the posterior arch of the hyoid a ceratobranchial, and the adjoining segment an epibranchial. The anterior pair of bones, in the body of the tongue, C, are naturally ceratohyals.

FIG. 1.

Hyoid of Grebe showing component bones, much enlarged.

- A First basibranchial.
- B Second basibranchial.
- C Ceratohyals.
- D Ceratobranchials.
- E Epibranchials.

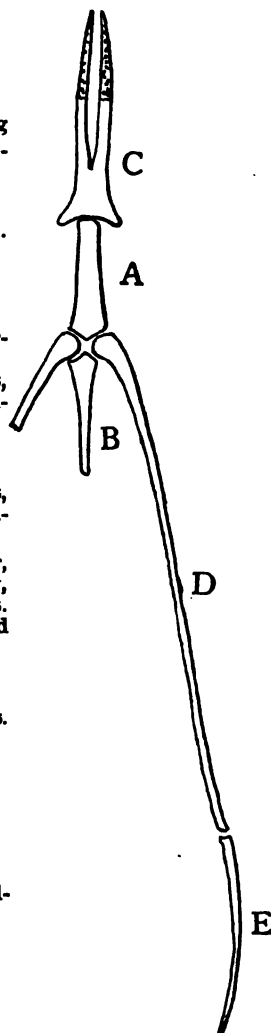
A { Basibranchial : Parker.
Basihyal : Mivart,
Gadow, Beddard-figure.

B { Basibranchial 2 : Parker.
Urohyal : Mivart,
Gadow, Beddard.

C { Ceratohyal : Parker,
Mivart, Gadow,
Beddard in part.
Basihyal : Beddard in part.

D { Ceratobranchial : Parker.
Thyrohyal : Mivart.
Basibranchial : Gadow.
Hypobranchial : Beddard.

E { Epibranchial : Parker.
Ceratobranchial : Gadow, Beddard.



The next question, that of the proper name for the anterior basal bone of the hyoid, A, calls for some reflection, since it involves not only the nomenclature of the hyoid in birds, but in mammals as well.

This bone is called basibranchial by Parker and basihyal by Gadow, this latter name being ordinarily used for the basal bone of the mammalian hyoid.

A true basihyal, or as it is better called from its relations, glossohyal, is found in fishes at the upper, anterior portion of the hyoid apparatus. It is also present in turtles, where it has the same relation to the tongue as in fishes, and where it ossifies some little time after the first basibranchial, with which it soon becomes confluent. It seems a little doubtful if a true basihyal occurs among birds, although the median piece of cartilage contained in the fleshy portion of the tongue and articulating with the fused ceratohyals in such birds as ducks may represent this bone. The question is one which the embryologist can readily answer. As pointed out by Parker, the true basihyal does not occur in mammals, the term being given to a bone that is morphologically the first basibranchial. It would seem that exact morphological nomenclature should reject the term basihyal for the first basal median bone in the hyoid of birds and mammals, including, of course, man, as there is no reason why human anatomy should stand as a stumbling block in the way of the student of comparative anatomy, although it has often done so.

F. A. LUCAS.

SCIENTIFIC BOOKS.

A Treatise on Universal Algebra. By A. N. WHITEHEAD, M.A., Fellow and Lecturer of Trinity College, Cambridge. Cambridge, University Press; New York, The Macmillan Co. Vol. I. Pp. xxvii+586. Price, \$7.50.

By 'Universal Algebra' is meant the various systems of symbolic reasoning allied to ordinary algebra, the chief examples being Hamilton's Quaternions, Grassmann's Calculus of Extension and Boole's Symbolic Logic. The present volume contains an exposition of the general principles of universal algebra, followed by a

separate detailed study of the Algebra of Logic and of the Calculus of Extension; the second volume will contain a separate detailed study of Quaternions and Matrices and a detailed comparison of the symbolic structures of the several algebras. The main idea of the work is not unification of the several methods, nor generalization of ordinary algebra so as to include them, but rather the comparative study of their several structures. But, it may be asked, if the branches of universal algebra are essentially distinct from ordinary algebra and from one another, what bond is there to connect them into one whole? A connecting bond is found in the generalized conception of space; the properties and operations involved in that conception are found capable of forming a uniform method of interpretation of the various algebras.

The work is well and clearly written and, when completed, will form an admirable presentation of the subject from the formal view of mathematical analysis. One excellent feature is conservatism in the use of symbols; by this means the author makes his pages easier reading to those who have already studied some of the special branches.

Another excellent feature of the volume consists in the Historical Notes appended to some of the chapters. In these Mr. Whitehead gives a brief history of the development of the special branch, so far as known to him, without making an exhaustive research. The importance of the Historical Notes probably calls for a more exhaustive research, as the work covers a great and growing province of mathematics and will, when completed, be considered one of the best authorities on its subject in the English language.

The feature which is most open to discussion is the view which the author takes of the fundamental nature of mathematics; and it is most important, for it determines the whole plan of the work. In the preface the author thus states his view, in very plain terms: "Mathematics is the development of all types of formal, necessary, deductive reasoning. The reasoning is formal in the sense that the meaning of propositions forms no part of the investigation. The sole concern of mathematics is the

inference of proposition from proposition. The justification of the rules of inference in any branch of mathematics is not properly part of mathematics; it is the business of experience or philosophy. The business of mathematics is simply to follow the rules. In this sense all mathematical reasoning is necessary, namely, it has followed the rules. Mathematical reasoning is deductive in the sense that it is based upon definitions which, as far as the validity of the reasoning is concerned (apart from any existential import), need only the test of self-consistency. Thus no external verification of definitions is required by mathematics as long as it is considered merely as mathematics. Mathematical definitions either possess an existential import or are conventional. A mathematical definition with an existential import is the result of an act of pure abstraction. Such definitions are the starting points of applied mathematical sciences; and, in so far as they are given this existential import, they require for verification more than the mere test of self-consistency. Hence a branch of applied mathematics, in so far as it is applied, is not merely deductive, unless in some sense the definitions are held to be guaranteed *a priori* as being true in addition to being self-consistent. A conventional mathematical definition has no existential import. It sets before the mind, by an act of imagination, a set of things with fully-defined self-consistent types of relation. In order that a mathematical science of any importance may be founded upon conventional definitions, the entities created by them must have properties which bear some affinity to the properties of existing things. Thus the distinction between a mathematical definition with an existential import and a conventional definition is not always very obvious from the form in which they are stated. In such a case the definitions and resulting propositions can be construed either as referring to a world of ideas created by convention or as referring exactly or approximately to the world of existing things."

In reply, it may be asked: Is geometry a part of pure mathematics? Its definitions have a very existential import; its terms are not conventions, but denote true ideas; its propositions

are more than self-consistent—they are true or false; and the axioms in accordance with which the reasoning is conducted correspond to universal properties of space. But suppose that we confine our attention to algebraical analysis—to what the treatise before us includes under the terms ordinary algebra and universal algebra. Are the definitions of ordinary algebra merely self-consistent conventions? Are its propositions merely formal without any objective truth? Are the rules according to which it proceeds arbitrary selections of the mind? If the definitions and rules are arbitrary, what is the chance of their applying to anything useful? The theory of probabilities informs us that the chance must be infinitesimal, and the author admits that the entities created by the conventions must have properties which bear some affinity to the properties of existing things, if the algebra so founded is to be of any importance. The author says 'some affinity;' it may be asked how much? Unless the affinity or correspondence is perfect, how can the one apply to the other? How can this perfect correspondence be secured, except by the conventions being real definitions, the equations true propositions, and the rules expressions of universal properties? In the last sentence quoted, Mr. Whitehead makes a large concession to the realist view; it is only necessary to change the sentence into—"In the case of any algebra worthy of scientific attention the definitions and propositions refer exactly or approximately to the world of existing things."

M. Laisant, in his recent work, '*La Mathématique*,' refers to the formal view of mathematical science when discussing the theory of fractions, p. 35. He opposes it, as marching in the direction opposite to progress, and as a survival of the spirit of the sophist.

The realist view of mathematical science has commended itself to me ever since I made an exact analysis of Relationship and devised a calculus which provides a notation for any relationship, can express in the form of an equation the relationship existing between any two persons, and provides rules by means of which a single equation may be transformed, or a number of equations combined so as to yield any equation involved in their being true

simultaneously. The notation is made to fit the subject, and the rules for manipulation are derived from universal physiological laws and the more arbitrary laws of marriage. A very real basis, yet the analysis has all the characteristics of a calculus, and throws light by comparison on several points in ordinary algebra.

But what is the subject of which ordinary algebra is the analysis? Quantity; and in space we have the most complex kind of quantity; so that if space can be analyzed, the analysis will serve for any less complex kind of quantity. Mr. Whitehead admits that, as a matter of history, mathematics has till recently been the science of number, quantity and the space of common experience. But "the introduction of the complex quantity of ordinary algebra, an entity which is evidently based upon conventional definitions, gave rise to the wider mathematical science of to-day. Ordinary algebra, in its modern development, is a large body of propositions interrelated by deductive reasoning and based upon conventional definitions which are generalizations of fundamental conceptions."

The imaginary quantity, more generally the complex quantity, of ordinary algebra is the foundation upon which the formalist builds his theory; if it can be shown that it is not an entity based upon conventional definitions, but corresponds to a reality, then his whole superstructure falls down. The complex quantity first arises in analysis in the solution of the quadratic equation. The general form of the root consists of a quantity independent of the radical sign and a quantity affected by the radical sign. When the quantity under the radical sign is negative the root is said to be imaginary, because it appears to be incapable of direct addition to the part independent of the radical sign. In certain papers recently published I have shown at length that the root of a quadratic equation may be versor in nature or scalar in nature. If it is versor in nature, then the part affected by the radical involves the axis perpendicular to the plane of reference, and this is so, whether the radical involves the square root of minus one or not. In the former case the versor is circular, in the latter hyperbolic. When the root is scalar in its nature

the two parts add to form the final result, but in the case where the square root of minus one is present the sign must be preserved in the intermediate processes of calculation. A complex index (both terms involving a sign of direction) has its meaning in an angle which is partly circular, partly hyperbolic; and a scalar complex quantity expresses the cosine or sine of such complex angle. It follows that the functions of a complex quantity can be defined really. It has been the practice of writers to follow the formal view, and define, for instance, the cosine of a complex quantity as the sum of a certain infinite series. Let z denote a complex quantity, then, according to that view, by $\cos z$ is meant the sum of the series

$$1 - \frac{z^2}{2!} + \frac{z^4}{4!} - \text{etc.}$$

But when the cosine of a complex angle is defined in the same manner as the cosine of a circular angle or of a hyperbolic angle, namely, as the ratio of the projection of the radius-vector to the initial line, then

$$\cos z = 1 - \frac{z^2}{2!} + \frac{z^4}{4!} - \text{etc.},$$

becomes not a dead convention, but a living truth.

In the first book the author states more fully the principles of universal algebra: "There are certain general definitions which hold for any process of addition and others which hold for any process of multiplication. These are the general principles of any branch of universal algebra. But beyond these general definitions there are other special definitions which define special kinds of addition or multiplication. The development and comparison of these special kinds of addition or of multiplication form special branches of universal algebra," p. 18. The general principles are as follows: Addition follows the commutative and associative laws, viz: $a + b = b + a$ and $(a + b) + c = a + (b + c)$. Multiplication follows the distributive law, viz: $a(c + d) = ac + ad$ and $(a + b)c = ac + bc$. Multiplication does not necessarily follow the commutative and associative laws, that is, $ab = ba$ and $(ab)c = a(bc)$ are laws of special branches only. It has been maintained by followers of Hamilton that the asso-

ciative law is essential to multiplication. It is true of spherical quaternions, but is not true of the complementary branch of vector analysis. It is satisfactory to find that Mr. Whitehead adopts the latter view, and, indeed, it is involved in his detailed exposition of vector analysis in the concluding book of his first volume.

But one who looks upon algebraic analysis not as the sum of several correlated branches, but as one logical whole, must consider the above principles or so-called definitions as arbitrary. For let p and q denote two quaternions, then $e^p e^q$ is not in general equal to $e^q e^p$; consequently e^{p+q} is not equal to $e^q e^p$; hence the commutative law does not hold in the addition of these indices. Thus to define addition as necessarily following the commutative law, and multiplication as not necessarily following it, is an arbitrary procedure.

In expounding the algebra of logic the author follows largely the exposition of Dr. Schroeder in his learned treatise, 'Vorlesungen über die Algebra der Logik,' but he does not take up the most valuable part of that work, namely, the Algebra of Relatives. Symbolic Logic as expounded by Schroeder differs essentially from the calculus devised by Boole in his 'Laws of Thought.' It was Boole's aim to keep as close as possible to ordinary algebra, and to make his method the foundation of a calculus of probabilities. In fact, the full title of his famous book is 'An Investigation of the Laws of Thought on which are founded the mathematical theories of Logic and Probabilities.' According to Boole the special peculiarity of the algebra is that $x^2 = x$, when x is an elementary elective symbol. Jevons is said to have introduced the further supposed law that $x + x = x$, which destroys the quantitative character of the calculus. Indeed, Mr. Whitehead says that the algebra is non-numerical, and in Dr. Schroeder's elaborate work no mention is made of probabilities. According to the more recent school $a - b$ supposes that b is included in a (p. 82), whereas Boole made no such limitation. It is a step backwards, just as it would be a step backwards in ordinary algebra to hold that $a - b$ carries the supposition that b is less than a .

The detailed exposition of Grassmann's system is excellent and will be welcomed by all who wish to assimilate the ideas of that great master of space-analysis. The last book of the present volume is on the application of the calculus of extension to geometry, and it is evident from the fourth chapter, entitled 'On Pure Vector Formulæ,' that the author considers vector analysis to be supplementary to quaternion analysis. They are not the same thing; and both gain when it is perceived that they are not redundant, but supplementary to one another.

In conclusion, the work reflects great credit on the author and on the Cambridge University Press; it is likely to lead to further advances in Universal Algebra, not only by what it lays down, but by the questions which it brings forward for discussion.

ALEXANDER MACFARLANE.

The Principles of Agriculture. By L. H. BAILEY.
New York, The Macmillan Company. 1898.
Pp. xx + 800.

'Principles of Agriculture,' by Professor L. H. Bailey and his associates in Cornell University, is a new volume in the Rural Science Series and in many respects is the most important one of the series, as it serves as an introduction to the others. The book is intended to be used as a text-book for schools and rural societies, but it will prove interesting and valuable for the agriculturally inclined who have had little or no training in the natural sciences. It is essentially a book for beginners, and as such serves its purpose better than any of the small hand-books which have attempted to treat of the elementary principles of agricultural science.

The volume is edited by Professor Bailey and some of the chapters are written by him; the remaining chapters are written by his associates, who are specialists in the departments of which they have written. At the end of each chapter are suggestions which serve to elucidate the text for readers whose knowledge of natural science or of rural affairs is scanty, and also give useful hints for teachers who may use the volume as a text-book.

In the introduction we are told that "agriculture is not itself a science, but a mosaic of many

sciences, arts and activities, or, a composite of sciences and arts, much as medicine and surgery are. * * * But the prosecution of agriculture must be scientific." The aim of the book is to deal with 'fundamentals' rather than 'incidentals.' "The mistake is often made of teaching how to overcome obstacles before explaining why obstacles are obstacles. * * * The purpose of education is to improve the farmer and not the farm." Would that more of our farmers could see the truth contained in these statements.

The book opens with a brief treatment of the formation of the different kinds of soils. On page 27 the author says: "The profit in agriculture often lies in making the soil produce more abundantly than it is of itself able to do." On page 202: "In intensive and specialty farming manures may be bought." These statements are true, but do not consist well with what is said about ideal agriculture on page 2. Inorganic compounds are explained as those which are not produced by living organisms, and phosphoric acid is given as one example, notwithstanding that a large amount of phosphoric acid used in commercial fertilizers is made from bone. Although the chemists call it an inorganic compound, yet because it is found in the remains of animals the reader who has had no knowledge of chemistry might be puzzled until some further explanation was made.

The second chapter, which is written by Professor Spencer, shows what is meant by 'texture' of the soil, why good texture is important and how to obtain it. That "the texture or physical condition of the soil is nearly always more important than its mere richness in plant food" is a fact not recognized by some tillers of the soil.

The 'moisture of the soil' and 'tillage' are next treated in a brief and creditable manner. Several figures are given to illustrate the art of plowing and one of an 'ideal general purpose plow.' All plowmen will think that this implement might be improved upon, but the low handles should be appreciated by everyone. The handles of many plows are too far from the ground.

Chapters IV. and V. treat of enriching the

soil. The former explains the method of handling home-made manure, while the latter has to do with commercial fertilizers only. Fig. 31 shows a 'common type of barnyard,' in which home-made fertilizers are allowed to go to waste, while in Fig. 30 is shown a model method of protecting them; yet the position of the watering trough is not an ideal one, looking at it from a sanitary point of view. Fig. 32 shows a 'handy and economical stable,' which, in reality, is anything but desirable. It might do for a makeshift while refitting an old barn, but it cannot be recommended to anyone who is planning to erect a new set of buildings.

Other chapters deal with plants, their propagation and subsequent care. It is misleading to say that germs or bacteria may cause constitutional troubles in the plant, as is done on page 167 and again on page 170, where we read that constitutional diseases are usually treated by burning the affected parts, which implies that such a plant may spread the disease if not destroyed. It is hard to see how a disease inherent in a plant (constitutional) can spread the disease to other plants, unless the affected parts of the diseased plant are used for propagation. Bacterial diseases may affect the internal structure of the host, although 'the cause of it is not apparent on the exterior,' yet such diseases are not constitutional any more than the diseases caused by the *Peronosporiaceæ*. Some biologists deny that there are any true constitutional diseases, while here we have constitutional diseases treated as something different from contagious diseases, but what that something is is not very clear.

The life-history of one parasitic fungus given in detail would have been a valuable addition, for it would have helped much to explain *why* it is that one plant can cause sickness in another, a fact which is hard for any person to understand who has not viewed microscopic preparations of fungi. In doing this the author would have followed out the aim 'to seek why before seek how,' as stated on page 15.

Contact insecticides is a better term than 'caustic insecticides,' for in many cases the insecticide clogs the breathing pores and causes death by suffocation rather than by caustic action on the tissues. Figs. 70 and 71 pretend to

show sucking and biting insects respectively, but the reader will not be able to see the distinction from the illustrations.

Many farmers would think twice before following the advice on page 187: "If the meadow fails to return two tons of field-dried hay to the acre, plow it up," for there are local conditions where less than two tons per acre may be a justifiable crop.

Chapter XIV., 'How the Animal Lives,' by Professor Law, and Chapter XV., 'The Feeding of Animals,' by Professor Wing, give summaries of our present knowledge of subjects of which our farmers, as a rule, do not know nearly so much as they should.

The last chapter, on the 'Management of Stock,' is by Professor Roberts. On page 266 he says that there are two theories respecting the number of animals to be kept on a farm. The fact is we are beyond the theory stage in this matter, and it can be said curtly that there are two methods, the practice of either one of which must depend upon local conditions.

The severest criticism to be made of the book is that nearly every subject discussed in it is treated in too brief a manner, a result inevitable in trying to expound the principles of agriculture in one book of only 300 small pages, printed in large type. This defect has been partially remedied by references to other literature for further study, although it is to be regretted that these references are confined mainly to the work of the editor's immediate associates. The arrangement of the contents is excellent, and on the whole the book is superior to any of its kind.

In closing, we quote again from the preface: "Agriculture is a business, not a science. * * * Business cannot be taught in a book like this; but some of the laws of science as applied to farm management can be taught."

ELISHA WILSON MORSE.

Elementary Zoology. By FRANK E. BEDDARD. New York, Longmans, Green & Company. 1898. 12mo. Pp. vi+208. 93 illustrations.

Every teacher examines with interest any new text-book dealing with the subject in which he gives instruction, and his interest is all the greater if the book is written by a recog-

nized authority and published by a reputable firm. He may find that the book treats the subject in a more satisfactory manner than the text he has been using, and hence be led to change. Or, if he cannot adopt the new book, he may learn from it much that is inspiring and suggestive of better methods of teaching. There are far too many teachers, however, who, having to give instruction in several subjects, have not become especially proficient in any one and are not fitted by experience and training to be competent judges of the merits of different texts. Zoology is one of those studies which are usually 'lumped' together and put into the hands of the 'teacher of science,' who, more often than not, is a physicist or a chemist by training and, consequently, not likely to be qualified to select a good text-book in zoology. Too often is the choice determined by the scientific reputation of the author, who may be of undisputed ability as an investigator, but not successful in his method of presenting his subject; or by the business enterprise of the book agent. Hence, it behooves those who are interested in raising the grade of instruction in the different scientific branches to exercise a careful watch to prevent, if possible, the introduction of text-books, and especially such as are elementary, which are faulty in method and inaccurate in the statement of facts. There is no reason why a new text-book should be issued unless it present the subject by a better method and be a distinct advance over those already published.

This elementary zoology "contains an account of a few types selected from the chief groups of the animal kingdom, followed and accompanied by a consideration of some of the more general conclusions of biology." The author adopts the very commendable plan of treating the types in the ascending order, beginning with a discussion of protoplasm and the amoeba. The fifteen chapters of the book deal with the unicellular animals; hydra; earthworm; crayfish; cockroach; metamorphoses of insects; pond mussel; snail; frog; skeletal and integumentary structures of vertebrates; the egg, sperm, and development of the chick; morphology of organs; morphology of tissues; classification; classification of animals. The most of these topics are discussed with a toler-

able degree of clearness, although paragraphs are not infrequent which must be read more than once before the meaning is grasped.

It is questionable whether an average high-school pupil could comprehend the author's treatment of the morphology of the skull and the development of the chick. The first cannot be understood without much elaborate dissection and comparison of specimens, nor the second without the use of sections, and the reconstruction of the latter either into a model or in the imagination is not within the capacity of the beginner.

There are so many grammatical and typographical errors that one is forced to believe that the book was carelessly written and hastily printed. For instance, a singular verb is not infrequently burdened with a plurality of subjects. The unbiased reader has his choice between 'spermathical' and 'spermathecal' pores in the earthworm. Hydra is figured as containing 'interstitial' cells and 'chromatophores,' and anodon as having a 'coelome.' Several figures, *e. g.*, 8 and 9, do not tally with their descriptions. Modifications of Maupas' figures of the conjugation of vorticella are given, but no description of the process accompanies them. The directions for preparing dissections are not always accurate. On p. 23 it is stated that 'when an earthworm is opened by a median incision along the back, and the flaps of skin turned back, the entire anatomy is revealed.' The student will find it necessary to do more than this before he will discover the nervous system. Again, on p. 63, 'when the mantle flap of one side is removed the structures shown in Fig. 29 are brought into view.' The pupil who accepts this statement in good faith will look in vain for the liver, pedal ganglion, connectives and commissures shown in the illustration. An anodon shell with the lines of growth running 'parallel with the long axis of the shell' (p. 62) would be a prize for any conchologist. The explanation of the gaping of the mussel shell after death (p. 62) has the advantage of novelty, if not of verity. It is interesting, too, to learn that the snail is a symmetrical animal, that its radula bears calcified teeth (p. 68) and that the blue color of its blood is due to the presence of 'hæncyanin,' p. 70.

English frogs have the tongue 'bifid at the tip,' and breathe in an uncommonly awkward manner. "When the frog breathes it fills the mouth with air; the mouth is then closed and the external nares, while the muscles forming the floor of the mouth force the contained air into the lungs" (p. 80). In the tadpole, respiration is carried on by a 'free flow of oxygen containing water over the gills.' The adult frogs are said to have 'two first vertebræ,' from which the student infers that they are double-headed. On p. 103 the author says: "The skeleton of the fore limb consists of the pectoral girdle and of the limb which articulates with it." The student is left to wonder which of the two limbs enjoys this distinction and why the other is not equally favored.

Nothing is said about geographical distribution; sponges are nowhere mentioned; in the chapter on histology there is no figure or description of bone, no figure of nerve cells or fibers, of striated muscle fibers, of glandular structures, nor of adipose tissue. There is no index. Most of the figures are good, but there are not enough to make certain of the subjects clear to beginners.

There would be no excuse for giving Mr. Beddard's zoology an extended notice were it not that the scientific prominence of its author and name of its publishers are likely to carry much weight and to lead to its introduction into American schools in the place of other and better books, and this should not happen until it has been given a thorough and radical revision.

CHARLES WRIGHT DODGE.

UNIVERSITY OF ROCHESTER.

Laboratory Exercises in Anatomy and Physiology. By JAMES EDWARD PEABODY, A.M., Instructor in Biology in the High School for Boys and Girls, New York City. New York, Henry Holt & Co. 1898. Pp. x + 79.

In view of the large amount of instruction in physiology that is given in secondary schools and the large number of text-books that exist, it is surprising how few attempts have been made to treat the subject practically by the preparation of laboratory directions. And the few attempts, although in several cases excel-

lent, are, without exception, inadequate. The immediate cause of this state of things is probably the lack of a demand by teachers for aids of this kind; and this lack of demand is probably to be traced to a lack of realization on the part of the majority of the teachers, themselves imperfectly trained in this respect, of the advantages of the practical method. Not a few teachers, however, have longed for help in endeavoring to raise the standard of instruction in this branch from its present alcoholic and narcotic condition, and such progressive ones will heartily welcome Mr. Peabody's book.

The book is apparently intended for high-school classes. Among the subjects treated are the human and mammalian skeleton, the muscles, the chemical testing of foods, digestion, absorption, the heart, the blood and its circulation, oxidation, respiration, the skin, the kidney, excretion, touch, taste, smell, yeast and bacteria. Directions for the use of the microscope and a list of apparatus and chemicals required for the exercises are added. The book is interleaved with blank pages for notes and is intended to be placed in the hands of the pupil. The latter is given simple directions for experimenting and, instead of being told what to observe, is asked concerning the results that follow. In this respect the book is in accord with the best of the practical guides in other departments of science. "The questions * * * have been framed with the object of leading the student to seek the facts *from the material itself*. The student should be trained especially to distinguish in the experiments *observed results* from the *inferences* that may be drawn from those results." This admirable intention is well carried out. To illustrate the care with which it is done one instance may be cited. After giving directions for making and using the common bell-jar apparatus to demonstrate the action of the diaphragm and lungs, the author asks the pertinent questions: "In what respects does this model illustrate the process of inhaling and exhaling air in our own bodies? In what respects does the model fail to illustrate the process of respiration?"

The book is preeminently a guide to the study of human physiology, and a large number of the experiments and observations are to be

made on the pupil's own body. It is interesting to see how much pure physiology, as distinct from anatomy, can be learned in this way, without the aid of complex apparatus, dissection or vivisection. Vivisection is neither employed nor referred to in any way in the book, and dissection only as it pertains to bones, muscles, the heart and the kidney. Anatomy is treated not as a finality, but as a basis for the study of function. The directions for the study of bacteria are excellent, and the practical applications of bacteriology include, among other things, the canning of fruits, the use of the tooth-brush, the cleaning of the streets, and the cleansing of wounds.

In the opinion of the reviewer physiology is usually taught in high-school courses too much as a human, and too little as a broadly biological, science. Hence some regret is unavoidable that in the present book more attention is not given to the comparative aspect. Notwithstanding this lack, the book is thorough, is calculated to arouse the interest and even the enthusiasm of the pupil, and is to be heartily recommended for use in schools.

FREDERIC S. LEE.

COLUMBIA UNIVERSITY.

BOOKS RECEIVED.

A Text-book of General Physics. CHARLES S. HASTINGS and FREDERICK E. BEACH. Boston, Ginn & Co. 1899. Pp. viii + 768. \$2.95.

The Development of English Thought. SIMON N. PATTON. New York and London, The Macmillan Company. 1899. Pp. xxvii + 415.

The Shifting and Incidence of Taxation. EDWIN R. A. SELIGMAN. New York and London, The Macmillan Company. 1899. Pp. xii + 337. \$3.00.

The Cambridge Natural History. Volume IX., Birds. A. H. EVANS. London and New York, The Macmillan Company. 1899. Pp. xvi + 635. \$3.50.

The Elements of Physical Chemistry. J. LIVINGSTON R. MORGAN. New York, John Wiley & Sons; London, Chapman & Hall, Ltd. 1899. Pp. xiii + 299.

Examination of Water. WILLIAM P. MASON. New York, John Wiley & Sons; London, Chapman & Hall. 1899. Pp. 135.

De la méthode dans la psychologie des sentiments. F. RAUH. Paris, Alcan. 1899. Pp. 305.

SOCIETIES AND ACADEMIES.

THE BIOLOGICAL SOCIETY OF WASHINGTON.

THE 19th anniversary meeting was held January 17th, under the auspices of the Washington Academy of Sciences, in the hall of the Columbian University, the occasion being the address of the retiring President, Dr. L. O. Howard, entitled 'Are Insects as a Class Injurious or Beneficial in their Relations with Man?' The paper was published in full in SCIENCE for February 17th.

The 301st regular meeting was held January 28th and was devoted to a consideration of the 'Great Dismal Swamp.' Dr. David White traced the geologic history of the swamp and surrounding regions, showing how successive periods of elevation and depression had resulted in the formation of a considerable area so slightly elevated above sea-level that the natural drainage is insufficient to remove the rainfall. It was stated that the present period is considered to be one of subsidence, and it was noted by later speakers that Lake Drummond is evidently increasing in size.

Mr. F. D. Gardner described the soils from a practical standpoint, with special regard to the agricultural possibilities of the land extensively reclaimed by drainage. Large deposits of peat exist, which it has not been found possible to utilize on a commercial scale. The water of the streams and drainage ditches is very strongly impregnated with the soluble products of the enormous quantities of decomposing vegetable matter, and, like the soil, has a distinctly acid reaction. This acidity of the soil may be so excessive as to interfere with its fertility, although inexhaustible quantities of plant foods are present.

Mr. Thomas H. Kearney exhibited a large series of photographs illustrating the characteristics of the flora of the swamp. The various plant-associations were enumerated and described at length, and their relative importance in the formation of humus was noted. Reference was also made to the possible effects of the acidity and generally low temperature of the water as agents likely to retard growth and to require adaptations against excessive transpiration. The woody type of vegetation predominates, there being very few herbaceous species

and these invariably perennials. Bulbs and creeping rootstocks occur, but the cespitose habit so common among dry-land plants is entirely absent. Notwithstanding the abundance of climbing woody vines and bamboo-like *Arundinarias* which give an aspect of tropical luxuriance, the flora is predominantly boreal in origin. Many northern plants have their southern limit of distribution here, and, on the other hand, several southern types have never been found farther north.

Mr. William Palmer continued Dr. White's discussion of the physiography, with particular reference to the changes due to human agencies. The vegetation becomes very dense along canals and ditches where formerly the swamp was comparatively open, as far as undergrowth was concerned. These ditching operations have been carried on since the days of George Washington, who spent considerable time in the Dismal Swamp in surveying and managing the work, and who died possessed of \$2,000 in stock in the enterprise.

It was stated that the drainage of the swamp is very intricate, the direction of the current being not infrequently reversed in the same channel. Miocene bivalve shells are found in great abundance near the northern end of the Jericho Ditch. Of existing animals there are thirty mammals, the more prominent of which are deer, opossums and wild cattle. Forty-one species of birds are regular summer residents, with many more transient visitors. The most characteristic bird of the swamp is perhaps the Prothonotary Warbler, a rare bird everywhere else, but not uncommon in the swamp. The resident birds and mammals in some instances show distinct characters, by which they may be readily separated from those of the neighboring drier regions, and have consequently been described as distinct species or subspecies. Fourteen species of fish are known from the waters of the swamp, although it is believed that none existed in Lake Drummond until admitted through the canals. Snakes may be said to be abundant, as Mr. Palmer has counted 153 while passing along one of the canals on a warm day. The King Snake is very tame and sometimes climbs into boats, but with no malicious intentions. Four frogs and six turtles were also enumerated.

In conclusion, Mr. Palmer stated his regret that the opportunity of holding the vicinity of Lake Drummond as a National Park had not been improved before its great natural beauties were so largely destroyed.

The 302d regular meeting was held February 11th, but, owing to the unusually severe and inclement weather, the attendance was small, and several members who had arranged to continue the discussion of the Great Dismal Swamp were absent. After electing to active membership Dr. Oscar Loew, of Washington, and Lieutenant Wirt Robinson, of New York, the Society voted to postpone the discussion and adjourn.

O. F. COOK,

Corresponding Secretary.

CHEMICAL SOCIETY OF WASHINGTON.

THE regular meeting was held on January 12, 1899.

The first paper of the evening was read by Dr. E. A. de Schweinitz, and was entitled 'The Serum Treatment of Some Animal Diseases.'

In this paper the author gave a general review of the work begun in 1890 in the study of the substances secreted by the hog cholera and the swine plague germ in relation to immunity. He further pointed out the production of an enzyme by the hog cholera and other allied germs, and their importance in producing in animals immunity from disease. From this point the work was extended to a study of the serum obtained from animals that had been immunized to disease, and this was found to contain an immunizing principle and exerted curative properties upon experimental animals affected with hog cholera and swine plague respectively. Following these experiments, practical work has been carried out in the field for several years, with very satisfactory results. The treatment with serum was found to save about 80 per cent. of infected herds, while in those herds not treated which served as checks the loss from disease was over 80 per cent.

In practical work in the field it is difficult to decide often whether the animals are suffering from either hog cholera or swine plague alone or both of these diseases. To overcome this difficulty it has appeared advisable to use a

curative serum for one of these diseases mixed with a curative serum for the other. For protective vaccination it appears advisable to use, in addition to the serum, the products of the bacteria as well as their cell contents, including the products of the secretion or excretion.

The second paper of the evening was read by Dr. F. K. Cameron, and was entitled 'On the Estimation of Nicotine,' by E. A. de Schweinitz, J. A. Emory and F. K. Cameron.

This paper described a critical examination of the analytical methods so far proposed, and with special reference to the so-called 'Kissling Method.' Attempts to devise a satisfactory method were made by formation of double salts with metallic compounds, precipitation of an addition compound with bromine or iodine, precipitation with picric acid, precipitation with phosphomolybdic or phosphotungstic acid, decomposition of accompanying amines with nitrous acid, decomposition of these compounds with hypochlorous or hypobromous acid, separation of the ammonia as oxalate by the addition of alcohol. The results were summed up as follows:

I. The so-called Kissling method was to be regarded as the best so far proposed. For the estimation of nicotine in tobacco leaves or powders it may be regarded as satisfactory, but its application to tobacco extracts yields very unreliable results.

II. A complete extraction of nicotine by ether and some other solvents is readily accomplished.

III. An evaporation of an ether extract will afford a practicable separation from ammonia alone, but not from other organic bases.

IV. A complete separation by distillation with steam is much more difficult than is usually supposed. Certain deviations from the usual practice were suggested.

V. No method involving the precipitation of the nicotine as an insoluble compound has been found practicable.

VI. No method involving the decomposition of accompanying compounds has been found practicable.

VII. The presence of tertiary amines, and probably some pyridin derivatives in tobacco extracts, is as yet an insurmountable obstacle in the separation or estimation of nicotine.

Finally, it is to be observed that nicotine comports itself as a tertiary amine. It does not yield a nitroso compound. Its separation from ammonia, primary and secondary amines, can be more or less readily accomplished by the adaptation of well-known general methods. Its separation from tertiary bases must be dependent on the discovery of some accidental physical or chemical property of the substance involved which cannot be predicated from known general principles. It would seem that a satisfactory solution of the problem is dependent upon some empirical relation, and it is in this direction that further investigation is indicated. But it is to be hoped that a more profound study of nicotine itself will yield satisfactory evidence as to its true nature, and from the knowledge thus gained the problem before the analyst may not be so aimless or complicated as it now seems.

WILLIAM H. KRUG.

Secretary.

MEETING OF THE NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY.

THE February meeting of the New York Section of the American Chemical Society was held on the 10th inst., in the Assembly Room of the Chemists' Club, at 108 West 55th street, Dr. Wm. McMurtrie presiding. In accordance with a resolution adopted by the Washington Section, it was resolved "that it be recommended to the Council that the Society confer, through appropriate channels, with the Chemical Society of London, as to the feasibility of the separate publication of their abstracts after the manner of the *Chemische Centralblatt*, the preparation of these abstracts to be undertaken by both Societies conjointly."

A report from the Committee on Patent Legislation was read, recommending that the present Committee be continued, with five additional members to be appointed by the chair.

The duty of the Committee will be to prepare such alterations and amendments as may seem advisable and submit them to the different members of the Committee as well as to the Sections of the Society before the first spring meetings. From the reports of the Sections in different parts of the country a general report will be

prepared for the next session of Congress in December.

The following papers were read :

'Recent Extension of Our Knowledge Regarding Nitrates as Plant Food,' Dr. J. A. Myers.

'A Method for the Analysis of Canned Condensed Milk,' F. S. Hyde.

'Manufacture of Ether,' Alfred Roos.

'Manufacture of a New Guaicol Compound,' L. H. Renter.

'Explosibility of Nitrogen Iodide and Acetylene Copper Compounds and Use of the Latter in Manufacture of Alcohol and Ether,' L. H. Renter.

'Chemistry of the Dynamite Process of Weighting Silk,' Rafael Granja.

'Chemistry of the Velocitan Process—Quick Tanning,' Rafael Granja.

'Melting Point as a Cyclic Function,' Thos. Bayley, England. Read by title.

DURAND WOODMAN,
Secretary.

GEOLOGICAL CONFERENCE AND STUDENTS' CLUB OF HARVARD UNIVERSITY.

Geological Conference, January 10, 1899.—

Dr. T. A. Jaggar, Jr. gave a communication on 'The Geology of the Northern Black Hills,' and illustrated it with many lantern views, photographs and specimens. He dwelt especially on certain facts, discovered by him during the past summer, which throw new light on the general problem of intrusives. These will be published in full later.

Students' Geological Club, January 17, 1899.—In a paper entitled 'Our Present Knowledge of the Geology of the Boston Basin,' Mr. R. E. Burke briefly summarized the literature on the geology of that area.

Geological Conference, January 24, 1899.—Mr. H. T. Burr presented some results obtained in mapping the conglomerates of the Boston Area with a view to determining their relative age. The Commonwealth Avenue cut in the Roxbury conglomerate shows a series which strikes transversely (E-W) to similar, adjoining conglomerates to the north and south. Evidence was offered to show that this structure is due to overthrusting from the north followed by normal faulting.

The Brighton amygdaloids have generally been considered as flows. The speaker held,

after a detailed study of their contacts, that these rocks are intrusive. Further, their injection was probably preceded by faulting.

In discussing this paper, Professor Shaler favored the division of the Roxbury conglomerates into formations, on the basis of recognized periods of denudation that alternated with periods of deposition.

Mr. Robert DeC. Ward spoke on 'Acclimatization of the White Man in the Tropics.' By acclimatization is meant adaptation to a new climate. This problem, although an old one for Europeans, has confronted us for only a few months. It arises as a result of physiological changes that take place in the body, and may be best studied from two points of view, (1) a consideration of these physiological changes, and (2) a study of the diseases most prevalent in the tropics which a resident there is most likely to contract.

In connection with the former part of the problem the chief factors are heat and humidity. Heat, in itself, is not dangerous; but it becomes so when significant humidity is added. Heat induces evaporation and thus greater desire for drink. Accordingly, considering a certain increase in drink necessary, those nations which drink hard liquor will suffer more than those which use wine. Cereals afford safer food than meats. In regard, then, to both liquid and solid food the southern Europeans have advantages over the English. Too much or too little exercise is extremely dangerous; a certain amount is absolutely necessary. The most healthy tropical districts are high and dry.

In connection with the latter part of the problem, three diseases are especially prevalent, namely, sunstroke, yellow fever and malaria. Sunstroke is chiefly influenced by the rains. Malaria, the greatest obstacle in acclimatization, comes with the rains, but is also closely related to soil conditions. Yellow fever, although varying with the rainy season, finds its check in elevation. Thus, in the respective countries, the following altitudes have been found to be about the upper limit of that disease: in the United States, 800 feet; in Mexico, 2,800 feet; in Brazil, 2,700 feet; and in Jamaica, 4,000 feet.

The chief physiological changes resulting from life in the tropics are increased respiration and

perspiration, a more rapid pulse, enlargement of the liver, anæmia, and perhaps a rise of body temperature. Hygiene, as is shown by statistics, is effective in reducing the death rate, and thus in making life possible for white men in the tropics. While a strong person may, with proper care, live nearly anywhere in the tropics, he does not become independent of the tropical climate. Accordingly, authorities agree, with only a very few exceptions, that true acclimatization of the white man in the tropics is impossible.

J. M. BOUTWELL,
Recording Secretary.

ACADEMY OF NATURAL SCIENCES, OF PHILADELPHIA.

January 24, 1899. MR. WITMER STONE made a communication on the Academy's collection of birds and its history. He quoted from Sclater to the effect that in 1852 the collection was the largest in existence. The work of American ornithologists from Alexander Wilson to those of our own time, most of whom had been more or less intimately associated with the Academy, was commented on and two of Wilson's types were exhibited. They were the only ones known to the speaker to be in existence, all the others having apparently been lost on the breaking up of Peale's Museum, of which they formed part. After commenting on the growth of the collection, Mr. Stone spoke of the modes of preservation and exhibition, dwelling on the advantage of keeping the bulk of the specimens as flattened skins in air-tight drawers. Fine specimens of recent taxidermic work were exhibited and contrasted with the 'stuffed' birds of half a century ago. The communication formed a most interesting contribution to the history of the Academy and will make part of the first number of the *Proceedings* for 1899.

A paper entitled 'Contributions to the Life-History of Plants, No. XIII,' by Thomas Meehan, was presented for publication.

January 31. PROFESSOR HENRY A. PILSBRY called attention to a small collection of shells from New Mexico and Arizona, received from Mr. Ashmun, whose zeal as a collector had increased the number of species of the region

from about a dozen to over one hundred. The snails are almost entirely confined to the mountains and they exhibit the characters of forms from archipelagoes, only one species of a genus being found on one mountain range. Six species of *Pupa* were from six distinct localities.

DR. P. P. CALVERT commented on the influence of the heat of the room in hastening the development of dragon-flies from nymphæ.

A paper entitled 'A List of Fishes collected at Port Antonio, Jamaica,' by Henry M. Fowler, was presented for publication.

February 7. MESSRS. GEORGE and WILLIAM S. VAUX, JR., made a communication on the Illecillewaet and Asulkan Glaciers of British Columbia. After Mr. George Vaux, Jr., had exhibited a large number of beautiful lantern views of the region, illustrating the distribution of peaks, glaciers and ranges, Mr. William S. Vaux, Jr., read a paper, which was afterwards presented for publication, describing in detail their investigations undertaken to determine the rate of recession of the two glaciers specially under consideration. The paper was also satisfactorily illustrated.

A paper entitled 'A New American Land-Shell,' by Edward G. Vanatta, was presented for publication.

February 14. DR. P. P. CALVERT called attention to the new catalogue of the dragon-flies of New Jersey, the section of the general catalogue of insects of that State confided to him by Professor J. B. Smith. The number of species of these insects has increased since the issue of the first catalogue in 1890 from 39 to 85. Middle-southern New Jersey has been touched but slightly and there is no doubt that other species will be added to the list.

EDW. J. NOLAN,
Recording Secretary.

NOTES ON PHYSICS.

THE MEASUREMENT OF INDUCTANCE.

OF the various electrical measurements which serve in the electrical testing laboratory, the measurement of the inductance (the exact electrical analogue of the moment of inertia of a rotating wheel) of a coil of wire is perhaps the most unsatisfactory. Mr. H. Martienssen (*Wiedemann's Annalen*, 1899, No. 1) has im-

proved the little known method of Puluj for measuring inductance by means of alternating currents. The method of Puluj was devised independently by Professor S. T. Moreland and reported to Section B at the Boston meeting of the American Association. The method, in its simplest form, is to connect two circuits in parallel between alternating current mains and adjust non-inductive resistances until the currents in the two branches are in phase, when the inductances in the two branches are directly as the resistances. To show when the currents are in phase an instrument called a *phase indicator* is used. This instrument is essentially a small induction motor without iron. It consists of two small coils with their planes vertical and at right angles to each other, surrounding a suspended aluminum or copper rod. These coils are connected, one in each circuit, and when the two currents are not in phase with each other the suspended rod is deflected. Martienssen modifies the instrument by winding one coil with two strands of wire, each strand being provided with separate terminals. One of these strands he connects in circuit as before, and the other constitutes a secondary coil in which a current is induced by the current in the primary strand. This induced current is sensibly in quadrature with the primary current, and by the use of an adjustable non-inductive resistance in this secondary circuit the instrument may be used, according to Martienssen, for the accurate measurement of much smaller inductions.

Puluj's method, as modified by Martienssen, is a zero method; it requires only a single adjustment; it does not require harmonic electromotive force, nor does the frequency of the e. m. f. need to be known; and it gives accurate results for inductances ranging from a few hundreds to many millions of centimeters. In short, we seem to have at last a feasible laboratory method for the accurate measurement of inductance.

W. S. F.

NOTES ON INORGANIC CHEMISTRY.

AN interesting discussion has been carried on during the last few years as to the constitution of inorganic compounds, especially of the

metal-ammonium bases, by Professor S. M. Jørgensen, of Copenhagen, and Professor Alfred Werner, of Zurich. Professor Jørgensen, to whom we owe so much of our knowledge of these bases, especially those of cobalt, chromium and rhodium, defends the constitution based on the present ideas of valence, which has been developed in its application to these compounds largely by himself on the basis furnished by Blomstrand. Professor Werner, feeling the insufficiency of the theories of valence to account for most of our complex inorganic compounds, has proposed a new theory of coordinated groupings, in which he seeks to account for the constitution not merely of the metal-ammonium bases, but also of all the complex inorganic compounds, including those containing water of crystallization. The last number of the *Zeitschrift für anorganische Chemie* contains the eleventh paper by Jørgensen and the fifteenth paper by Werner. In the former Jørgensen reviews Werner's theory, replies to all the objections Werner has raised to the valence theory as applied to the metal-ammonium compounds, shows the insufficiency of Werner's theory, and finally, by an ingenious piece of chemical logic, shows that Werner's own theory must, if consistently carried out, lead him to Jørgensen's own formulæ for these compounds. In this paper, and that of Reizenstein, recently mentioned in this column, one may get a good view of the arguments on both sides of the controversy.

WERNER's paper in the same number of the *Zeitschrift* is confined to a study of the application of his theory to the double chlorides. He has tabulated all the double chlorides from the whole field of chemical literature, and grouped them in types according to his theory, considering also the water of crystallization present.

It is yet too soon for any final judgment to be pronounced on Werner's theory, especially because the field to which it applies is so immense. The limitations of the valence theory are, however, only too keenly felt by chemists, and Werner's work is leading in the right direction. At all events, this lengthy controversy is productive of much good. It has turned the

minds of many chemists to the necessity of broader views of chemical compounds; it has stimulated many chemists to fuller investigations in the inorganic field, and it has led at the hands of the two leaders to a vast enrichment of our chemical knowledge of large classes of compounds. We may add that for the most part it has been conducted in the best spirit.

IN the Trans-Caucasian region, from the Black Sea to the Caspian, are scattered many mud volcanoes, both in the naphtha regions and elsewhere. In the *Zeitschrift für anorganische Chemie*, P. Melikoff describes the analyses of the products of one of these mud volcanoes, that of Achala. The principal ingredients of the water are salt and soda. The solid matter is chiefly a plastic clay, with fine grains of calcite, feldspar and quartz. The greater part of the paper is a discussion of the origin of the soda and of sodium carbonate deposits and waters in general. The experiments of the author show that in the presence of ferric or aluminum hydroxid, as well as of colloidal substances and zeolites of the soil, sodium sulfate and calcium bicarbonate react readily with formation of sodium carbonate, and the same is true of sodium chlorid and calcium bicarbonate. The hydroxid present, and in soils the colloidal substances, hold the reaction products with different degrees of firmness, preventing reverse reactions and allowing in natural leaching process the separation of these products. Thus in the latter reaction the ferric hydroxid has a greater capacity for absorbing soda than for calcium chlorid, hence the latter is first removed by washing, and the later wash waters contain largely soda. Similar reactions take place in the presence of ammonium carbonate, which is present in most soils. Thus the natural soda formation is attributable to the interaction of salt or sodium sulfate, on the carbonates dissolved in natural waters in the presence of the soil.

J. L. H.

CURRENT NOTES ON ANTHROPOLOGY.

LINGUISTICS OF THE CHACO.

THE very few students of South American languages may be interested to learn that in the 'Proceedings' of the American Philosoph-

ical Society for October, 1898, I have published a paper of thirty pages, together with a linguistic map, on the languages of the Chaco region, embracing portions of the Argentine Republic, Paraguay, Brazil and Bolivia. The map covers the area from lat. 20° to 30° south, and long. 56° to 66° west from Greenwich. In this area the colors define the extensions of nine linguistic stocks, based on the most recent investigations. Especial interest attaches to the newly-found Ennima stock, first recognized as such by Guido Boggiari in 1895, although vocabularies of it had been printed before that date. While this paper does not solve all the problems of the Chaco tongues, it certainly diminishes their number.

THE CRANIOLOGY OF CRIMINALS.

WHAT are the differences between the skulls of criminals and those of 'respectable people'? This is the question which M. E. Pitard undertook to solve by comparing the crania of fifty-one convicts who had died in the penal colony of New Caledonia, with the average crania of the citizens of Paris. Practically, there turned out to be no constant difference at all, unless it was that the vertical index of the criminal skulls was slightly higher; in other words, the convicts were 'brainier' than the good folks. There was also the same amount of variation in the heads of the criminals. Some were long, others broad-skulled; some had a notably large, others a small cubical capacity; these variations running parallel to those of the general population. M. Pitard's article, with abundant data, is in the *Bulletin* of the Anthropological Society of Paris, 1898, Fasc. 3.

THE FOLK-LORE OF THE FJORT.

THIS is the title of the latest volume issued by the Folklore Society of Great Britain. It is written by R. E. Dennett and edited by Miss Mary H. Kingsley. The 'Fjort' is the name applied to the negro tribes of the French Congo, who once formed the great native kingdom of Congo. The volume is much more than a collection of folk tales. Miss Kingsley in the introduction and the author in his commentary and notes furnish fresh and valuable information on the religious beliefs, marriage and burial customs and mode of life of these

semi-savage peoples. Their songs and stories are carried in the memory by strings of objects each of which corresponds to a heading or line. These songs take us into the arcanum of the savage mind and present a strange picture of its psychology. The volume is illustrated and forms a welcome addition to the series published by the Society.

D. G. BRINTON.

UNIVERSITY OF PENNSYLVANIA.

SCIENTIFIC NOTES AND NEWS.

THE United States Fish Commission steamer *Fish Hawk* left Porto Rico for the United States on February 23d, having completed her work in the waters about the island and having visited all the principal ports. No details of the expedition have yet been received, but the most interesting results are expected from the operations on the sandy submarine plateau which extends to the eastward of the island.

THE French Geographical Society has awarded its medals, the two chief gold medals being given, respectively, to General Gallieni for his work in Madagascar and to M. E. Gentil for his explorations in Africa. The Félix Fournier prize has been awarded to M. Henri Brenier for commercial explorations in China.

MR. W. H. PREECE, C.B., F.R.S., having attained his sixty-fifth birthday, has retired from the position of Engineer-in-Chief and Electrician to the English Post Office, but it is hoped that his services will be retained by the Postmaster-General as consulting engineer.

PROFESSOR ALBERT F. BRIGHAM, of Colgate University, sailed on February 21st for Europe for ten months. He is now enjoying a sabbatical year, and will spend the time in geographical study in England and Switzerland, and in literary work for several months at Oxford. He will probably make arrangements to be with Professor Davis for a trip in the summer through parts of the Alps.

PROFESSOR R. VON WETSTEIN, of Prague, has been appointed Director of the Botanical Gardens of Vienna and professor in the University.

PROFESSOR WALTER WISLICENUS, of the University of Strassburg, is intending, with the as-

sistance of the German Astronomical Society, to prepare a yearbook of astronomy, giving abstracts of the papers appearing during each year, beginning with 1899.

THE death is announced of The Rev. William Colenso, F.R.S., at the age of 87 years. Mr. Colenso began life as a printer, and when the Church Missionary Society established a press in New Zealand, in 1833, he was given charge of this and became both printer and missionary. He was one of the chief authorities on Maori antiquities and rites, and on the natural history of New Zealand.

WE regret also to record the following deaths: Mr. John Kreusi, a mechanical engineer and inventor, at Schenectady, N. Y., on January 22d, aged 56 years; Mr. Thomas Cook, a well-known teacher of anatomy and writer on the subject, in London, on February 8th; Dr. L. A. Veitmeyer, a civil engineer at Berlin, and Dr. Carl Schoenlein, of the Zoological Station at Naples, at the age of 40 years.

THE New York Academy of Sciences proposes to hold its sixth annual exhibition in the American Museum of Natural History on April 11th and 12th. The first evening is reserved for members of the Academy and the second for the Scientific Alliance and friends of science in general. The afternoon of the 12th will offer an opportunity for students and those who cannot attend in the evening. The exhibition will illustrate the advances during the last year only. Any worker in the field of science who may have material which he believes of interest to the scientific world should communicate immediately with the chairman of the committee, Professor William Hallock, Columbia University, New York City. The exhibition is not limited to the work of members of the Academy, but the committee has final authority as to what material will be accepted. The departments represented are: Anatomy, astronomy, botany, chemistry, electricity, anthropology, ethnology, experimental psychology, geology, mineralogy, paleontology, photography, physics, physiography, physiology and zoology.

THE National Educational Association will meet next year in Chicago. Mr. A. B. Down-

ing, Superintendent of Normal Schools, New York City, has been elected President.

OFFICERS for the International Association for Promoting the Study of Quaternions and Allied Systems of Mathematics for the years 1889 and 1900 have been elected as follows: *President*, Sir Robert Ball, of Cambridge University; *General Secretary*, Dr. Alexander Macfarlane, lecturer on mathematical physics in Lehigh University. The Secretary of the United States is Professor Arthur S. Hathaway, of the Rose Polytechnic Institute.

THE Association of Polish Men of Science and Physicians will meet at Cracow in 1900. It will be remembered that the meeting in Posen last year was forbidden by the Prussian government for political reasons which scarcely appeared to be sufficient.

THE British Board of Agriculture have appointed a Departmental Committee to inquire into and report upon the working of the Diseases of Animal Acts in so far as they relate to glanders, and to consider whether any more effective measures can, with advantage, be taken to prevent the spread of that disease. Lord Stanley is chairman of the committee.

A MEETING of the Fellows of the Royal Botanic Society was held on February 11th, at the Gardens, Regent's-park, Mr. C. Brinsley Marlay presiding. Mrs. Ernest Hart exhibited a collection of Japanese dwarfed plants grown under certain secret methods much in vogue in the cultivation of trees in Japan. Each specimen was said to be upwards of one hundred years old, and the tallest was less than 18 in. in height, although possessing all the characteristics of perfect plants in miniature. They were pronounced to be the finest specimens of this peculiar art ever seen in England. There was also shown a seed incubator in action intended for use in connection with the 'Seed Control' lectures now being given in these Gardens every Monday.

THE first ordinary meeting of the British Society of Engineers for the present year was held on February 6th. Mr. W. W. Beaumont, the President for 1898, occupied the chair and presented the premiums awarded for papers read during the year, viz., the President's gold medal

to Mr. W. Fox, the Bessemer premium to Mr. S. O. Cowper-Coles, the Rawlinson premium to Dr. J. C. Thresh and a Society's premium to Mr. G. Thudichum. Mr. Beaumont introduced the President for the ensuing year, Mr. John Corry Fell, who delivered his inaugural address. He said, as reported in the *London Times*, that the financial position of the Society was very satisfactory, and it had increased its numbers during 1898. During the past year they had lost six of their honorary members—Sir William Anderson, Sir Henry Bessemer, Sir James N. Douglas, Sir John Fowler, Lord Playfair and Sir Robert Rawlinson. The vacancies thus created had been filled by Sir J. Wolfe Barry, Sir A. J. Durston, Sir David L. Salomons, Professor A. B. W. Kennedy, Mr. W. H. Preece and Mr. A. Siemens. It was a curious fact that civil engineers availed themselves less than any other members of the profession of the privileges accorded to inventors by patent, designs or copyright protection. It had been said that the British nation was less inventive than the American, and prior to 1883 that view appeared to be supported by the number of patent applicants in the United States as compared with those in Great Britain, but upon a reduction of the fees in 1883 the applications had reached over 30,000 per annum, and Great Britain now took a foremost place in the inventive world. With regard to successful invention the conditions should be the result of analysis or synthesis, not mere chance dashes into an unknown field. Mr. Fell pointed out the necessity of having a special Court for the trial of patent actions. He had for long past been of opinion that such a Court should be established, and of late the Lord Chancellor and other Judges had expressed the same views. They had publicly attributed the block in the Law Courts to the increasing number of patent cases and the inordinate time many of them occupied. The President then gave a short summary of the advances made of late years in various departments of engineering. A hearty vote of thanks was accorded to Mr. Fell.

THE annual meeting of the British Institution of Mechanical Engineers was held on February 9th at the new building in Storey's-gate, St. James's-park. Mr. S. W. Johnson, the re-

tiring President, being in the chair. Mr. Edgar Worthington, the Secretary, presented the 52d annual report, which showed that the membership in all classes had reached 2,684, representing a net gain of 191 on the previous year. The receipts for the year were £8,452, and the expenditure £7,588, leaving a balance of £863. The total investments and other assets amounted to £66,462. References were made to the experiments carried on by Professor Beare at University College as to the value of the steam-jackets, and to those of Sir William C. Roberts-Austen, who had carried to a successful conclusion a long series of experiments made at the Royal Mint on the behavior of steels during cooling. Congratulatory allusion was made to the summer meeting held at Derby, and it was stated that the next summer meeting would be held at Plymouth. The report was adopted, after which Mr. Johnson vacated the chair in favor of the President-elect, Sir. W. H. White. The fifth report of the Alloys Research Committee on Steel, drawn up by Sir William Roberts-Austen, was afterwards read.

A HYGIENIC institute is to be erected in Posen, Prussia. According to the *British Medical Journal* it will contain a hygienico-bacteriological and a pathologico-anatomical department, with the usual staff of directors and assistants. Their sphere of work is to comprise supervision and improvement of water supplies, of drainage works and the bestowal of refuse; soil and subsoil examination; hygienic supervision of works, factories, warehouses, etc.; prevention of the spread of infectious diseases; *post-mortem* examinations; courses of lectures, some popular, on subjects connected with hygiene, bacteriology and pathological anatomy. It is hoped that the scientifically-conducted efforts of the institute will be successful in arresting epidemics, such as cholera, smallpox, typhus, etc., which frequently have come into Prussia from across the Russian frontier.

THE *Times* states that at the South Foreland lighthouse, in the presence of representatives from the Councils of Dover, Ramsgate, Margate, Broadstairs, Sandgate, etc., trials have been made, under the supervision of Signor Marconi,

of his system of telegraphing without wires, between the East Goodwin lightship, twelve miles out at sea, and the lighthouse. The system acted well, the messages being received and recorded on the tape with absolute accuracy, Signor Marconi had with him two assistants at the lighthouse, Messrs. Kemp and Cohen, and one on the lightship, Mr. Richards, but several of the messages were sent by men on the vessel who had been instructed in the work. The height of the pole used for transmission was 130 feet, and Signor Marconi considered that by this a message could be sent to the French coast. The receiving wire on the lightship was run 80 feet up the mast. During the recent severe weather the system has worked perfectly, and the men on the ship have sent messages that have been transmitted to Ramsgate. All present were impressed with the demonstration, and promises of support to a resolution urging the Board of Trade and the Admiralty to take up the system were given.

A LAW was recently passed in Norway, says the *New York Medical Record*, prohibiting the sale of tobacco to any boy under sixteen years of age without a signed order from an adult relative or employer. Even tourists who offer cigarettes to boys render themselves liable to prosecution. The police are instructed to confiscate the pipes, cigars and cigarettes of lads who smoke in the public streets. A fine for the offence is also imposed, which may be as much as twenty-five dollars.

UNIVERSITY AND EDUCATIONAL NEWS.

MR. AGASSIZ AND HARVARD UNIVERSITY.

THE following minute on the Corporation records of Harvard University concerning the services and gifts of Mr. Alexander Agassiz are given in the Annual Report of President Eliot:

Voted, That in accepting from Mr. Alexander Agassiz the deed of gift which has been read, and which will be entered in full on the record of this date, the Corporation wish to enter on their records a statement of Mr. Agassiz's services and gifts to the Museum of Comparative Zoology:

From 1860 to 1865 Mr. Agassiz was Agent of the Museum and Assistant in charge of Worms, Echinoderms and Acalephs.

During part of the year 1866 he was in charge of the Museum while Professor Agassiz was absent in Brazil. In 1869, on his return from a three years' residence at Calamut, he was appointed Assistant in charge of Radiates, but without salary. Early in 1874 he was made a member of the Faculty of the Museum, Curator, and a member of the Board of Trustees. In 1876 the Museum was transferred to the University by its Trustees. Mr. Agassiz has never received any salary as Curator.

Between September 1, 1871, and September 1, 1897, Mr. Agassiz expended for the benefit of the Museum from his private means, without making any communication on the subject to the President and Fellows, over seven hundred and fifty thousand dollars, including his expenditures on objects now formally transferred to the Corporation, beside contributing about fifty thousand dollars to other University objects in gifts known at the time to the President and Fellows.

The great sum expended for the Museum is divisible into the following items which are taken from Mr. Agassiz's private accounts :

Land, Buildings and Fixtures.....	\$219,007.00
Cases, Collections and care of same..	223,867.00
Publications	118,127.00
Subscriptions to Agassiz Memorial Fund and for State grants (condi- tional).....	65,000.00
Library.....	26,695.00
Salaries.....	27,051.00
Deficits Humboldt Fund (Students).	8,260.00
Fuel.....	7,807.00
Interest.....	9,568.00
Laboratory Supplies.....	3,100.00
Naples Table.....	1,473.00
Wood's Hole Fish Commission Tables	500.00
F. C. Gray Bust.....	355.00
Not analyzed ; old accounts not ac- cessible.....	41,008.28
	\$751,818.28

Of the total expenditure about \$107,000 was for current expenses, or expenses which cannot now be specified ; the remainder is represented to-day by important parts of the land, building funds, collections, cases, fixtures, publications and library.

The Corporation record here their gratitude for these great gifts, distributed over a period

of twenty-six years, and for devoted services rendered to the Museum in various capacities ever since 1860, with one interval of three years, 1866-1869.

THE CLIMATOLOGICAL LABORATORY OF THE UNIVERSITY OF NEW MEXICO.

DURING the past two years the University of New Mexico has been carrying on some work looking toward a scientific investigation of the climatology of the plateau, especially with respect to its beneficial effects in cases of tuberculosis and analogous diseases. Statistical information has been collecting, and special studies in the variation in vital capacity among students in the University and the public schools of the Territory have been carried on. The biological and bacteriological departments, under the special direction of President Herrick and Professor Weinzirl, have taken up the study of air and water and the conditions of sepsis, etc. It has been hoped to extend this investigation to include the physical and chemical characteristics of the climate and also a study of the blood changes due to altitude, with special reference to the virulence and curtailment of the diseases in question.

A few weeks since Mrs. Walter C. Hadley made to the University a proposition to donate to the institution the sum of \$10,000, to be used toward the erection of a building to contain the laboratories for this and allied research. This gift was conditioned upon the raising of \$5,000 for the completion of the building and a similar sum for equipment. The Regents have agreed to establish the chair necessary to continue and prosecute the research, and are making an earnest effort to secure the subscription of the amount requisite to secure Mrs. Hadley's donation. The location of the University is probably unsurpassed for such research, and the faculty already contains a corps of bacteriologists and biologists acquainted with the lines of work to be opened, several of whom have personal familiarity with the beneficial results of the climate.

One interesting result of the studies so far made is the evidence that a residence on the plateau during the growing years of later childhood serves in a large measure to correct the

narrow chests and limited vital capacity resulting from a bad heredity. It is hoped that a considerable response in the way of subscriptions will come from those interested outside the Territory, as the recent financial stringency has left those who would gladly respond incapacitated to carry the entire burden. It is understood that subscriptions may be sent to Hon. F. W. Clancy, Mayor of the City of Albuquerque, or to C. L. Herrick, President of the University.

GENERAL.

WE are glad to learn that Washington University, St. Louis, has just received generous gifts enabling it to remove to its new site facing Forest Park. This site was purchased with a fund of \$200,000, contributed by seventy-five different subscribers. Funds for a library, to cost \$100,000, are in the hands of the directors by the bequest of the late Stephen Ridgley. The following additional buildings have now been given by members of the Board of Directors: (1) A hall of languages, costing \$200,000, by Mr. Robert S. Brookings; (2) an engineering building, costing \$150,000, by Mr. Samuel Cupples, and (3) a chemistry building, costing \$100,000, by Mr. Adolphus Busch. Mr. Brookings has also offered \$100,000 on condition that \$500,000 be subscribed at once for an endowment. St. Louis is, in size, the fourth city of the United States, and the University is now ready to take its place among the leading institutions of America.

MR. PHILIP D. ARMOUR has given \$750,000 to the Armour Institute of Chicago, which he had previously endowed with \$1,500,000.

THE will of the late Alexander M. Proudfit, of New York City, gives \$30,000 to Columbia University for two fellowships, one in letters and one for advanced studies in medicine. There are also numerous other bequests to public institutions, including \$10,000 each to the Public Library and to the New York Free Circulating Library.

KNOX COLLEGE, at Galesburg, Ill., has collected a fund of \$100,000, thus securing the additional gift of \$25,000 made by Dr. D. K. Pearsons.

AT a recent annual meeting of the Patent

Nut and Bolt Company (Limited), held at Birmingham, the sum of £5,000 was contributed to the fund which is being raised for the establishment of a University in the City of Birmingham.

PRESIDENT SETH LOW, of Columbia University, was the University Day Orator of the University of Pennsylvania at its annual celebration on Washington's Birthday.

THE Register of Lehigh University, South Bethlehem, Pa., for the year 1898-99 shows but few changes in the teaching force. Professor Langdon C. Stewardson has assumed the duties of the chair of mental and moral philosophy, and the new professorship of history and economics has been filled by the election of Mr. John L. Stewart, late lecturer in that department. The department of mechanical engineering has lost the services of Messrs. B. H. Jones and L. O. Danse as instructors, and their places are filled by Messrs. L. N. Sullivan and J. C. Peck. Messrs. John Boyt and F. O. Dufour have been promoted from the grade of assistant to that of instructor, and Mr. Joseph Barrell has been elected instructor in geology and lithology. Solid geometry has been added to the requirements for entrance to the Latin Scientific course and to that in Science and Letters; and it is announced that in 1900 and thereafter the requirements for entrance to the course in Science and Letters, or to any course in the School of Technology, will include Plane Trigonometry and Logarithms, through the solution of right and oblique triangles. The elective system has been extended to the Latin Scientific course, so that it now seems to be possible for a student in either of the literary courses to complete before graduation one-half or more of any one of the technical courses. Such a student might, therefore, complete in six years the general training of the literary course and the special training of a professional course, and would in the end be much better equipped for professional work than one who had taken the technical course alone. The principle of elective studies is introduced also into the technical courses. In the course of Civil Engineering the student may elect a large amount of work in Architecture, in addi-

tion to the designing and structural work of the regular course, and thus be fitted to take up on graduating the profession of an architect. In the courses of Mechanical and Electrical Engineering a large proportion of the work is identical, and students in either course may in addition elect a considerable amount of special work in the other course, under the advice of the Faculty, as a substitute for the same amount of work in his own course.

EFFORTS are being made to persuade President Taylor not to leave Vassar College for Brown University. With this end in view a meeting of the Alumni decided to try to collect the sum of \$2,000,000 for the endowment of Vassar.

It is announced that Mrs. Julia J. Irving will retire from the presidency of Wellesley College in June of the present year.

DR. MYRON D. GREEN has been appointed lecturer on photographic chemistry in the University of Cincinnati. A yearly course has been established in the subject, including each week one lecture and one afternoon of laboratory or field work. Our universities are beginning to recognize the importance of thorough and exhaustive instruction in this special branch of chemistry.

AT a meeting of the electors to the professorship of pathology of Cambridge University, held on February 11th, Mr. German Sims Woodhead, M.D., Edinburgh, was chosen to succeed the late Professor Kanthack. The *London Times* states that Professor Woodhead is the eldest son of Mr. Joseph Woodhead, formerly M.P. for Spen Valley, and was born at Huddersfield in 1855. He was educated at Huddersfield College and at the University of Edinburgh. He first became a teacher in anatomy and then pathology, and carried on original investigations in pathology in the Minto-house School of Medicine, the University of Edinburgh, the Edinburgh Royal Infirmary, and the laboratory of the Royal College of Physicians, Edinburgh. For upwards of eight years he has held the post of Director of the Laboratories of the Conjoint Board of the Royal College of Physicians and of the Royal College of Surgeons. He was Assistant Commissioner to the Royal Com-

mission on Tuberculosis, and his report was published in 1895. He has published a treatise on practical pathology, and, in conjunction with Dr. Arthur W. Hare, has published 'Pathological Myrology.' He has also written on bacteria and their products. He has held the office of President of the Royal Medical Society.

THE Balfour studentship of Cambridge University, of the annual value of £200, for original research in biology, especially animal morphology, has been awarded to J. Stanley Gardiner, M.A., Fellow of Gonville and Caius College, for three years from March, 1899. Grants from the Balfour Fund of £50 each have been made to J. S. Budgett, B.A., of Trinity College, in aid of his researches on the development of *Polyp-terus*, and to L. A. Borradaile, M.A., of Selwyn Hostel, in aid of the expenses of his proposed journey in company with Mr. Gardiner, the Balfour student.

AN examination will be held at Merton College, on June 27th and following days, for the purpose of electing to three open natural science scholarships, of which one will be at Merton College, one at New College and one at Corpus Christi College. The scholarships are of the value of £80 per annum, and are open to all candidates, including, we believe, those who are not citizens of Great Britain, whose age on July 3, 1899, will not exceed 19 years. The subjects of examination will be: (1) chemistry, mechanics and physics, or (2) biology. An English essay, and a paper in algebra and elementary geometry, will also be set to all candidates. Candidates will have an opportunity of showing a knowledge of higher mathematics.

DR. DOMENICO SACCARDO has been appointed professor of botany in the University of Bologna; Dr. Fleurens, professor of technical chemistry in the Conservatoire des Arts et Métiers at Paris; Dr. Natanson, of Vienna, assistant professor of mathematics in the University of Cracow, and Dr. Moritz Hoernes, assistant professor of prehistorical archaeology in the University at Vienna. Dr. Bing has qualified as docent in chemistry in the University at Bonn, and Dr. Emden as docent in physics and meteorology in the Technical Institute at Munich.

SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; J. LE CONTE, Geology; W. M. DAVIS, Physiography; O. C. MARSH, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; HENRY F. OSBORN, General Biology; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; J. McKEEN CATTELL, Psychology; DANIEL G. BRINTON, J. W. POWELL, Anthropology.

FRIDAY, MARCH 10, 1899.

CONTENTS:

<i>Explosions Caused by Commonly Occurring Substances</i> : PROFESSOR CHARLES E. MUNROE.....	345
<i>The American Morphological Society (II)</i> : PROFESSOR BASHFORD DEAN.....	364
<i>Stalactites of Sand</i> : J. S. DILLER.....	371
<i>Scientific Books</i> :—	
<i>Talbot's Degeneracy</i> : PROFESSOR G. T. W. PATRICK. <i>Skinner's Synonymic Catalogue of the North American Rhopalocera</i> : PROFESSOR T. D. A. COCKERELL. <i>Graftigny's Industrial Electricity</i> : W. H. F. General. <i>Books Received</i>	372
<i>Scientific Journals and Articles</i> :.....	375
<i>Societies and Academies</i> :—	
<i>Section of Anthropology and Psychology of the New York Academy of Sciences</i> : DR. CHAS. B. BLISS. <i>Onondaga Academy of Science</i> : H. W. BRITCHEE.....	376
<i>Discussion and Correspondence</i> :—	
<i>What is the Cause of the so-called Tobacco Formation?</i> DR. OSCAR LOEW. <i>The Anæsthetic Effects of a Sinusoidal Current of High Frequency</i> : DR. E. W. SCRIPTURE	376
<i>Notes on Physics</i> :—	
<i>The Metric System</i> : T. C. M. <i>The Electrolytic Interrupter for the Induction Coil</i> : W. S. F. <i>The Resistance of Carbon and Copper Brushes</i> : F. C. C.....	377
<i>Enzymes as Remedies in Infectious Diseases</i> : B. T. GALLOWAY.....	379
<i>Scientific Notes and News</i>	379
<i>University and Educational News</i>	383

MSB. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

EXPLOSIONS CAUSED BY COMMONLY OCCURRING SUBSTANCES.*

ON the sixth of November last the country was startled by learning that an explosion had occurred in the Capitol at Washington which had caused extensive damage to that magnificent and historic building, and which, with the ensuing fire, had destroyed some and jeopardized more of the valuable archives with which the building was stored. Occurrences of this kind have long had a particular interest for me, and I have found them to recur with great frequency and to cause extensive damage and destruction not only to property but to person. Notwithstanding, therefore, that much that I have to say is well known, it appears to be not inopportune to address you on the subject of 'Explosions Caused by Commonly Occurring Substances,' omitting entirely from consideration the substances commonly known and used as explosives, and it is possible that this repetition may serve to some extent in preventing these accidents by leading to greater precautions being taken.

From the observations on the phenomena accompanying the combustion of solids it is well understood that the speed of the combustion is greatly accelerated by comminuting the combustible and mixing it in-

* Address of the President before The American Chemical Society, New York Meeting, December, 1898.

timately with the supporter of combustion, and it is also well recognized that many explosions are due solely to very rapid combustion, yet it is only within comparatively recent times, and since manufacturing operations have come to be carried on upon a very considerable scale, that we have had it strongly demonstrated that ordinarily combustible solids might, when finely divided and mixed with air, give rise, on ignition, to most violent and disastrous explosions, and it seems especially notable that the first well demonstrated cases of this kind should have arisen from the apparently harmless operations attending the grinding grain, and the more particularly as flour is not looked upon as a very readily combustible substance when compared with other commonly used solids.

Among the many instances of this kind which we have now on record we will cite that which occurred on the 9th of July, 1872,* when the inhabitants of Glasgow were startled by the report of an explosion which was heard to a considerable distance and which was found to have occurred in some very extensive flour mills, the front and back walls of which were blown out, while the interior was reduced to ruins, and speedily enveloped in flame which destroyed the remaining buildings. Several persons were killed, and a number of others were severely burned, or injured by the fall of masonry.

On May 2, 1878, a similar disaster occurred in the enormous flour mills in Minneapolis, but in this case it was observed that the explosion which originated in the Washburn mill was communicated by flame successively to the Diamond mill and to the Humboldt mill. As a consequence of these explosions, the walls of these mills, which were solid masonry, six feet thick at the base, were razed to the ground; sheets of corrugated iron roofing, two by six feet in

area, were projected to a distance of more than two miles; a wooden building fifty feet from the center of explosion was burst open; stout plate glass windows one-fourth of a mile away were torn out bodily, sash and all, and projected into the street; an immense volume of smoke and flame was projected to an estimated height of six hundred to eight hundred feet, and finally persons by the edge of the adjacent river observed a displacement of water, producing a wave estimated to be eighteen inches high, before they heard the report of the explosion. The concurrent testimony of persons employed in the mills, and of the experts who were called, proved the absence in each case of any of the so-called explosive substances on the premises and that the boilers had not burst, and from the facts brought out the origin was conclusively traced to the striking of fire by a pair of mill-stones, through the stopping of the 'feed,' and the consequent friction of their bare surfaces against each other, with the result that the mixture of air and fine flour-dust surrounding the millstones became ignited.

This ignition alone would not suffice to develop any violent explosive effects; for similar ignitions which have been not infrequently observed in small mills, where they have been caused by the stones 'striking fire' or by the incautious use of a burning lamp near the millstones, or the meal-spout attached to them, have not been attended by any serious results. But in an extensive mill, where many pairs of stones may be at work at one time, each pair has a conduit attached, which leads to a common receptacle called an exhaust box; into this the mixture of air and very fine flour-dust which surrounds the millstones is drawn by means of an exhaust fan, which is sometimes aided by a system of air-blowers. The fine flour is allowed to deposit partially in this chamber or exhaust box, and the air then passes into a second cham-

* Abel, Roy. Inst., March 12, 1875.

ber, called a stive room, where a further quantity of dust is deposited. It follows that when the mill is at work, these chambers and the channels are all filled with an inflammable mixture of the finest flour-dust and air, and that the ignition of any portion of the inflammable mixture will result in the exceedingly rapid spread of the flame throughout the whole, and will thus develop an explosion. The violence of such explosions depends much upon the details of construction of the exhaust boxes and stive rooms, and upon the dimensions of the channels of communication; it must obviously be regulated by the volume of the inflammable mixture through which the fire rapidly spreads, and upon the degree of confinement. In the case of the catastrophe at Glasgow the production of a blaze at a pair of millstones was observed to be followed by a crackling noise as the flame spread rapidly through the conduits leading to the exhaust box upon an upper floor, and a loud report from that direction was almost immediately heard. Professors Rankine and Macadam, who carefully investigated the cause of this accident, report* that other flour-mill explosions which they had inquired into had been observed to have been attended by a similar succession of phenomena to those noticed upon this occasion. The bursting open of the exhaust box by a similar though less violent explosion, attended by injury of workmen, the blowing out of windows and loosening of tiles, appears to have taken place on a previous occasion at these particular mills. In the last and most disastrous accident, however, the more violent explosion appears to have been followed by others, the flame having spread with great rapidity to distant parts of the mills through the many channels of communication in which the air was charged with inflammable dust, resulting from the cleansing and sifting opera-

tions carried on in different parts of the building, and rapidly diffused through the air by the shock and blast of the first explosion.

In the experimental investigation of the Minneapolis explosion by Professor S. F. Peckham* it was shown that compacted masses of flour which had become heated and charred ignited readily and smouldered, but were inflamed only with considerable difficulty, though the atmosphere of the conduit from the stones, through which a strong current of air is being continually drawn and which is filled with a dense cloud of very fine particles of flour heated to a maximum temperature of 140° F, could be inflamed with comparative ease. White-hot wires and glowing charcoal were incapable of producing this inflammation, and only burned the particles in actual contact with them, and the only means by which the mixture, in the best proportions, could be made to burn explosively was by contact with flame.

The danger in the process was found to arise from the friction of the stones heating the last portion of the grist that remained between them to a temperature sufficient to char it or to convert it into a substance resembling tinder, which would readily ignite from a spark produced from the stones striking together. Although this burning mass could not inflame the dust-laden atmosphere, it did ignite wood, which a strong draught of air readily forced into a blaze. Under the conditions described with a draught of air passing through the dry stones strong enough to convey the pellets of smouldering tinder into the wooden conductor an explosion was a necessary consequence.

Knowing the chemical composition of flour, we may calculate approximately the mechanical work which a given mass of flour can perform, and find that the con-

* *Abel, Roy. Inst.*, March 12, 1875.

* *Am. J. Sci.* 16 (3), 301-306; 1878.

tents of an ordinary sack, when mixed with 4,000 cubic feet of air, will degenerate force enough to throw 2,500 tons mass to a height of 100 feet. If we now consider the many tons of flour there must have been in a mill such as the Washburn 'A,' where as much as 1,000 pounds of dust per day was collected from a single pipe, we can readily comprehend how such great destruction could be wrought.

It is to be regretted that the experts who duly considered all the circumstances concluded that, while, by suitable precautions, the frequency of these flour-mill explosions may be diminished and the extent of the damage inflicted may be very much restricted, the nature of the operations is such that these explosions cannot be altogether prevented.

Since mixtures of wheat-dust with air have proved to be so explosive, we should naturally expect that analogous solids would form similar explosive mixtures with air, and, as a fact, we have recorded explosions of oatmeal in the Oliver mill in Chicago, of starch in a New York candy factory,* of rice in rice mills, of malt dust in breweries, of spice dust in spice mills, together with numerous instances of sawdust explosions, the more prominent being those which occurred in the Pullman car shops and at Geldowsky's furniture factory in Cambridge, Mass., still we should scarcely look for an explosion from such a cause in a soap factory. Yet a violent explosion occurred in 1890, in a Providence soap-works, in which the finely powdered saponaceous substance known by the trade name of 'Soapine' was being prepared, and the Coroner held in his finding that the explosion through which such injury was inflicted was caused by the ignition of soapine dust. Experiments made in this connection showed that this substance will explode

under certain conditions with more violence than flour and apparently with the production of more heat.

The most unusual case of dust explosions, however, with which we have met was that of finely powdered metallic zinc which occurred at the Bethlehem Zinc Works in 1854. At that time Col. Wetherill devised a plan for utilizing the 'blue powder' which is the finely divided metallic zinc that is deposited in the prolongation of the condenser by swedging the powder into blocks and piling these blocks one above another in a furnace where they were melted down and run into spelter. The workmen in charge sought to facilitate the process by feeding the uncompressed powder directly into the furnace, but on trying to do so an explosion followed the loading of the first shovelful, and with such violence that the workman was blown from the top of the furnace and the blade of the shovel was driven into the roof of the building.

In pharmacy and the arts substances have been made either knowingly or accidentally from mixtures of combustible substances and supporters of combustion which have given rise to accidents, such as those from the parlor match and the chlorate troches,* or from sodium peroxide and sodium bisulphite mixtures, as in the Whitecross Street explosion,† and the latter class of mixtures are to be particularly dreaded as the chemical action and subsequent explosion may be incited not only by contact with fire, but also by contact with water. Cavazzi ‡ points out that mixtures of sodium nitrate and hypophosphite detonate on heating, while Violette § proposed to use a mixture of sodium nitrate and acetate as a substitute for gunpowder, and these are but a few among the many explosive mixtures which may be compounded.

* *U. S. Nav. Inst.* 11, 774; 1885.

† *J. Soc. Chem. Ind.* 13, 198-200; 1894.

‡ *Gaz. Chim. Ital.*, 1886.

§ Berthelot sur la force de la poudre (3) 2, 315.

* L. W. Peck, Explosions from Combustible Dusts, *Pop. Sci. Month.*, 14, 159-166; 1878.

Still another source of danger arises from the production and use in laboratories, and, frequently in common life, of chemical substances which are explosive *per se*, though not generally recognized as such, and we have records of accidents, among others, from bleaching powder,* from erythryl nitrate, which has lately come into use in the treatment of Angina Pectoris,† from ammonia nitrate,‡ and there are many others, such as the organic nitrates,§ nitroso compounds,|| diazo bodies,¶ diamides,** hydrozoic acid and its derivatives,†† hydroxylamines,‡‡ chlorates,§§ carbonyl compounds,|||| permanganates,¶¶ peroxides,*** chlorides††† and iodides,‡‡‡ occurring in the laboratories and used to a varying extent in the arts that are so unstable as to give rise to serious accidents if incautiously handled. We may notice that so well known a compound as the cupric ammonium nitrate, a body which is often formed in the course of analysis, was deemed by Nobel to possess such value as an explosive that he took out patents for its use in blasting.

The liquid state conduces more particularly to accidents taking place since bodies in this state are liable to escape from their receptacles and to be found in unexpected places. If combustible, when mingled with the atmosphere or when saturating oxidizing agents they burn with extreme rapidity

and produce very violent effects. When such liquids give off vapors at the ordinary temperatures, or those prevailing during use, the danger is very materially increased, as such vapors are more vagrant and, through diffusion, readily mingle with the atmosphere. These properties are especially characteristic of many of the products obtained from coal tar and from petroleum, bodies whose cheapness, abundance and special adaptability have led to their extended use for domestic heating and lighting and for many purposes in the arts, but which have, because of this widespread use and in consequence of their possessing the properties named, been the cause of an enormous number of casualties. Dr. C. F. Chandler* showed that much of the danger attending the use of these oils in lamps could be avoided by the elimination of the paraffines of low boiling points, and though not the pioneer, yet largely through his active efforts and the agitation which followed them, this principle has properly become widely embodied in legislation. This view as to the source of danger was confirmed by the experiments of Newbury and Cutter,† who found that all the paraffines below nonane formed explosive mixtures with air at the ordinary temperatures, notwithstanding that the boiling point of octane is 124°C., and that the limit of a safe oil as fixed by the 'flashing test' defined by the New York State statutes is reached only in decane. Yet this last-named compound formed a violently explosive mixture at the legal flashing temperature if but a small quantity of the liquid was placed in the copper testing vessel, thus indicating that entire safety is not assured in its use and that accidents might occur when it is used in lamps so constructed that the oil chamber becomes highly heated. Dewar‡

* Petroleum as an Illuminator; Rept. N. Y. City Board of Health for 1870.

† Am. Chem. J. 10, 356-362; 1888.

‡ Rept. H. M. Insp. Exp. 21, 55; 1897.

* Rept. H. M. Insp. Exp. pg. 47; 1897.

† Rept. H. M. Insp. Exp. pg. 50; 1898.

‡ J. Chem. Soc. 683; 1882.

§ Compt rend 109, 92-95; 1889.

|| Comp. rend 108, 857-859; 1889.

¶ Annalen 121, 257; 1860.

** J. Prk. Chem. 30, 27; 107.

†† Bericht. 23, 3023; 1890.

‡‡ Rec. d. trav. Chim. Pays Bas 10, 101; 1891, and J. Chem. Soc. 54, 425; 1888.

§§ Compt rend. 105, 813; 1887.

|||| Bericht. 18, 1833; 1885.

¶¶ J. Chem. Soc. 54, 230; 1888.

*** Compt rend. 106, 100; 1888.

††† Bull. Soc. Chim. 50, 635-638.

‡‡‡ J. Chem. Soc. 56, 766; 1889.

holds that the relative volatility of petroleum oil is a subject which is not sufficiently known and appreciated. By comparing the loss of weight during 24 hours of oils exposed in shallow vessels under similar conditions, he found at 66° F. an American water white oil of 106° flash point lost 20.4 per cent., an oil of 75° flash point lost 27.4 per cent., and a Russian oil of 84° flash point lost 28 per cent.

In observations that I have made it was very apparent that the form and material of the containing vessel are most important factors in these volatilization experiments. I have found, for instance, that a given volume of gasoline placed in an uncorked vial and exposed to the ordinary atmospheric conditions of a laboratory required 10 weeks for complete volatilization when the same volume of the same lot of gasoline placed in an evaporating dish standing beside the bottle volatilized completely in 8 hours. The rate of evaporation of various hydrocarbons under the same conditions has been studied by Boverton Redwood.*

A menace in the use, storage and transportation of these liquids rests in the rapidity with which their vapors diffuse through the air and form an explosive train which reaching out to a source of ignition flashes back with extreme rapidity through the entire train and to its point of origin. Sir Frederick Abel cited an instance of this which happened at the Royal College of Chemistry in 1847 when a glass vessel in which benzene was being converted into nitro-benzene broke and allowed the warm liquid to escape and flow over a large surface. Though the apartment was 38 feet long, 30 feet wide and 10 feet high, and the only ignited gas jet was at the end of the room most remote from the glass vessel, yet, in a very brief space of time after the vessel

broke, a sheet of flame flashed from the gas jet and traveled along the upper part of the room to the point where the fluid lay scattered.

Also he cites the explosion of benzoline at the mineral oil store in Exeter in 1882. The store rooms were arched caves in the side of a bank facing a canal and separated from it by a roadway about 50 feet wide. There was a standing rule forbidding any light being taken to any of these store rooms when they contained petroleum spirit, but on the day in question it was desired to remove some of the benzoline in the early morning and the foreman visited the store rooms before daylight to make ready for the work. Forgetful of the rule, he carried a lighted lantern, which he placed on the ground some 27 feet away from the cave, and was proceeding to open the door when he observed a strong odor of benzoline and almost immediately noticed a flash of flame proceed from the lantern to the store and had barely time to turn to escape when an explosion took place which blew the doors and lantern across the canal and inflamed the spirits in the store rooms.

Of course, the distance that these vapors will travel will be determined by the circumstances of each individual case, but in the case of the fire at the L. & N. W. R. Co.'s gas factory in February, 1897, through which the hydrocarbons in a cylinder that was being rolled across the yard about the works became ignited, the nearest source of ignition was found in the boiler fires, which were 60 feet away.*

Conditions such as these are more likely still to obtain when these inflammable and volatile substances are stored in enclosed spaces, such as the hold of a vessel during transportation, and they have been the cause, under these conditions, of many frightful accidents. As an example of these we have the case of the explosion on Novem-

* 'Detection of Inflammable Gas and Vapor in the Air,' Frank Clowes, p. 191, 1896; London.

† Roy. Inst. of Great Britain, March 13, 1885.

* Rept. H. M. Insp. Exp. 22, 57; 1898.

ber 21, 1888, on the petroleum-laden ketch 'United' at Bristol, England, through which the docks were blown up, three men killed and several injured, the glass in the windows shattered for a radius of upwards of 300 feet, and extensive damage done by fire.

The accident was made the subject of a special report by Col. V. D. Majendie* which contains the results of his investigation and the experiments by Dr. Dupré and Mr. Boverton Redwood, from which it appears that the material on the 'United' was 'deodorized naphtha' in forty-two gallon barrels; that the average annual leakage on petroleum oil in barrels amounted, in 1874, to 8 per cent. and on petroleum spirit to double this quantity, and that, though there has since been a great improvement in the treatment of the barrels, it is still very large; that one volume of the liquid gives 141 volumes of vapor at ordinary temperature having a specific gravity of 3.5 to 3.8; that one volume of the liquid will render 16,000 volumes of air inflammable, 6,000 most violent explosive, 5,000 strongly explosive, and 3,000 scarcely explosive but combustible. The naphtha vapor alone or when mixed with air in the best proportions was not ignited by a shower of sparks from flint and steel; by a stream of sparks from fireworks of various kinds burning without flame; by incandescent match ends, or by incandescent platinum heated by electricity to a red heat. Even red-hot coals held over and sometimes falling upon a small quantity of the spirit spilled on a wooden floor failed usually to ignite it, and the cause in those cases in which ignition did take place in these red-hot coal experiments was uncertain, as there was a fire burning in a near by room. Ignition was, however, certainly effected by the application of a flame or by contact with a platinum wire approaching incandescence.

* Eyre & Spottiswoode, London, 1889, 30 pp.

The 'fireworks' test makes a striking lecture experiment, especially the one devised by Mr. Redwood with 'vesuvians,' or incandescent cigar lighters. For this purpose he attaches two, of the glowing variety, to a wire so that the tip of one will be in contact with the base of the head of the other. The latter is lighted, and when it ceases to flame, and only glows, the mass is thrust into the explosive mixture, where it remains with the combustion, progressing from tip to base and base to tip without other effect until, when flame bursts from the tip of the second vesuvian, the vaporous mixture surrounding it is ignited and an explosion ensues.

Col. Majendie has properly called attention in this report to the fundamental distinctions between the danger arising in the transportation of a cargo of dynamite and one of petroleum spirits, since in the former case an explosion does not take place until fire is brought to the dynamite, while in the latter case the dangerous vapors will travel to a fire at a considerable distance and even through intervening bulkheads.

For this reason mixed cargoes of which volatile inflammable liquids and explosives constitute a part are particularly dangerous, as was long since shown in the explosion of the canal boat 'Tilbury,' in Regent Park, in 1874, having on board five tons of gunpowder and four barrels of benzoline and also having a small fire burning in the after cabin some 35 to 40 feet from the forehold in which the petroleum was stored. Notwithstanding that the cargo was covered with tarpaulins and that there was an intervening bulkhead, the vapors reached the fire and a most devastating explosion followed. The cargo was thus made up in spite of a similar disastrous experience from similar causes on the 'Lottie Sleigh,' at Liverpool, in 1864,* and neither of them have proved a sufficient warning to alto-

* Abel, *loc. cit.*

gether prevent subsequent reckless disregard of all dictates of common prudence.

Yet, because of these experiences, attempts have been made in some instances, where small lots of spirit were taken by vessels, to avert disaster by carrying them as deck loads, but the experience on the 'Solway,' which carried 24 barrels of this article on the main deck before the poop, shows that this does not ensure security, for, meeting with heavy weather, the casks broke adrift, their vapors reached the galley or cabin fires, and the vessel, with 19 persons, was lost.

Even where great precautions are taken to prevent accidents they not infrequently occur from inflammable substances being met with in unexpected places, or being introduced surreptitiously in admixture with harmless bodies. Nowhere, perhaps, is more care taken in this respect than on passenger steamships and in the naval service, yet 18 years ago a series of accidents occurred on board English ships, the cause of which was for a time veiled in mystery and which, in the then-existing state of feeling consequent on the dynamite outrages, aroused the gravest apprehensions.

In June, 1880, a violent explosion took place, without any warning or apparent cause, in the forepeak of the Pacific Steam Navigation Co.'s steamer 'Coquimbo,' shortly after her arrival in Valparaiso. Several plates were blown out of the bow, and other structural damage was inflicted while the ship's carpenter, who was the only person apparently who would have thrown any light on the cause of the accident, was killed.

This explosion was followed on April 26, 1881, by a much more serious one on the man-of-war 'Doterel' (while at anchor off Sandy Point, in the Straits of Magellan), through which eight officers and 135 men lost their lives and the vessel was destroyed.

In May, of the same year, an explosion

of trifling character happened on H. M. S. 'Cockatrice,' in Sheerness Dockyard; while in November one, which was sufficiently severe to kill two men, dangerously wound two more (one fatally) and injure six others, besides doing much damage to the ship, occurred on H. M. S. 'Triumph,' then at Coquimbo.

The first suggestion as to the real cause of these accidents was obtained in the investigation of that on the 'Cockatrice,' when it was developed that, just previous to the explosion, a man went into the store room with a naked light which he held close to a small can, that was uncorked at the time, and which contained a preparation recently introduced into the naval service (as a 'drier' for use with paint) under the name of Xerotine Siccative, and that this largely consisted of a most volatile petroleum product. As it had been issued without knowledge of this fact, instructions were at once sent out by the Admiralty directing that it should be stored and treated with the same precautions as turpentine and other highly inflammable liquids or preparations; and these instructions had but recently reached the 'Triumph' when the accident narrated happened to her. Inquiry here developed the fact that the explosion originated in the paint room through bringing a lantern to a compartment in which a leaky can of Siccative had been stored, and following up this clue the explosions on the 'Coquimbo' and 'Doterel' were fully and definitely proved to have been due to the presence on board of this same substance; while experiments with the material showed that it was capable of producing all the destructive effects observed, except, perhaps, in the case of the 'Doterel,' where, from the two reports noted and the other resemblances to the Regent Park explosion, there was but little doubt that the powder magazine was also exploded.

Such accidents were not, however, con-

fined to British vessels, for on October 13 1891, while the U. S. S. 'Atlanta' was going to the rescue of the wrecked 'Tallapoosa' an explosion occurred on the 'Atlanta,' which caused her immediate return to New York. I was at once ordered by the Secretary of Navy to proceed to New York and investigate the accident.

I learned that while the 'Atlanta' was laboring in a heavy sea she sprung a leak through the hawse pipes and the forward collision compartment began to fill with water; that a handy-billy was rigged to pump the compartment; that about midnight the suction pipe became plugged, and that on lowering a common lantern into the compartment an explosion ensued, severely injuring two men, slightly injuring four others and bulging the steel collision bulkhead. I found that the collision compartment had been used as a store room for paints; that among them were spar and damar varnishes and Japan dryer, each of which gave off inflammable vapors at ordinary temperatures; that the packages were sealed in a very insecure manner, and that, as this compartment filled and the vessel tossed, the cans were opened and their contents churned up so as to readily form explosive mixtures with the air.

I learned further that on June 15th previous a fire and explosion had taken place on board the U. S. S. 'Philadelphia' in close proximity to her powder magazine, and that another had occurred on the U. S. S. 'Bennington,' all being evidently due to the same material.

But notwithstanding these vigorous lessons the tale continues, and on April 14, 1896,* a 'petroleum accident' occurred on board the Cunarder S. S. 'Servia' when a party of men were engaged in painting the inside of a water-ballast tank. The tank, which was 3 feet 6 inches deep, was divided into 16 compartments, with 18 inches aper-

ture between each. The farthest compartment was being painted at the time, and it was necessary to crawl through 15 of the small apertures to reach it. The paint used was styled Patent Bitumastic Solution, and one of the survivors testified that it took him four or five minutes to reach the compartments, ten minutes to do the painting, and four or five minutes to return, and that he could not stoop down any longer, as it made him dazed and queer in his head. All the witnesses testified that the use of the solution in confined spaces made them drunk and delirious if they remained any length of time at work. This is a well-known effect of the lighter petroleum, and it is not surprising that the solution was found to consist of coal tar dissolved in crude oil, having a flashing point of 45° F. Abel, and containing so much volatile matter that one gallon spread over a large surface would render 48 cubic feet of air inflammable.

Notwithstanding this the workman went into this inner compartment, which was already partly covered with the freshly-laid solution and containing a partly-filled bucket of it, with a lighted candle. Some time having passed without hearing from him, another workman went to his assistance and found the place on fire and the man burned and delirious. He was so delirious as to fight against coming out, and it took an hour and a-half with assistance to get him through the apertures and up the manhole, and he afterwards died in the hospital from the effects of the disaster.

Even while writing this we learn from the local press that a fire, preceded by an explosion, due to the use of Bitumastic Solution, occurred at the Central Market House, Washington, D. C., on November 16, 1898.

The notorious 'Hair Dresser's Accident' of June 26, 1897, through which Mrs. Samuelson was fatally injured in London, by the ignition of a petroleum hair wash

* Rept. H. M. Insp. Exp. 21, 53; 1897.

which was being used as a shampoo, illustrates anew the manifold uses to which these hydrocarbons are being put, and it brought out strongly the belief of competent authorities, like Lord Kelvin, that these substances could be ignited by frictional electricity; a theory which had been offered before in explanation of accidents in which there was no other apparent source of ignition.

The widespread distribution of these spirits in the hands of retailers, or as used for carburetters in isolated vapor-lighting plants and as employed in the arts for solvents, cleansing agents and for other purposes has led to their accumulation, through leakage or by being discharged after use, in low places, such as cellars, cisterns, wells, sewers and the bilges of ships, where they have remained, in some instances for long periods of time, unknown and unnoticed, their origin even being completely forgotten and untraceable, until, when, in the course of events, these out-of-the-way places have been reentered, these bodies have given rise to accidents. It is a well-known precaution of the past before entering a well or cave to test its atmosphere for carbon dioxide by means of a naked candle, but this very method of procedure has, since the introduction of petroleum, been the cause of accidents, and to be assured of security we must now remove and test the air before entering.

The extended consumption of naphtha for carburetting water gas, and the ease with which it is conveyed through pipes, has resulted in the use of systems of pipe lines in our cities to carry the oil from the transportation lines or store tanks to the works. Such a line was laid in Rochester, New York, and on December 21, 1887, it gave rise to an explosion which killed three men, seriously injured twenty, destroyed three large flour mills, tore up the streets for a considerable distance and inflicted an esti-

mated loss of \$250,000. This pipe line, which was made of 3-inch wrought-iron pipe, one and one-half miles in length, had been in successful use for six years, the spirits being pumped through it every two weeks in lots of from twelve to fifteen thousand gallons each. From the Appeal Book *in re Ann Lee vs. The Vacuum Oil Co.*, Rochester, 1889, we learn that the conveyance of the naphtha was complete on December 7th; on December 8th the contractors constructing a sewer exposed a section of the pipe line for several feet, and in blasting beneath it a piece of rock struck the pipe with sufficient force to bend it up nearly nine inches at the point struck and to separate it at a joint farther on underground and closely connected with a sewer; that on the day fixed for the next delivery, December 21st, the Oil Company, being unaware of the then-existing conditions, pumped the full supply into the pipe, none of which reached the gas works, but, on the contrary, found its way, by the broken joint, into the sewers, and was thus distributed over the city; that the pumping of the oil began at 12:15 p. m.; the odor was noticed shortly after 1 p. m., coming from a sewer at a point nearly a mile distant from the break; the first explosion occurred at this point at 3:20 p. m., and immediately extended westward back to the break and eastward to the outlet of the sewers, tossing up manhole plates, uplifting roadways and overturning buildings; that the explosive mixture was ignited by a fire under a steam boiler, and that this vapor found its way from the sewer to the fire through an untrapped water closet at a point where exhaust steam was being injected into the sewer.

At the trial, Mr. F. L. King, p. 173, stated that crude naphtha, flashing point 13°F., percolated through earth six times as fast as water at the same temperature, his several experiments being made with tem-

peratures varying for the liquids from 38°F. to 60°F. and for the earths from 32°F. to 60°F. Mr. George B. Selden, p. 178, found the mixture of naphtha and air in the best proportions, to give, on explosion, a pressure of 140 pounds per square inch, while coal gas and air in the best proportions gave 160 pounds per square inch, and that the ignition point of the naphtha mixture was 950°C. while that of the coal gas mixture was 800°C.

I have already referred to the means taken for ensuring the removal of the more volatile hydrocarbons from domestic kerosene, a subject which has been very exhaustively treated by Rudolph Weber.* It has, however, been seriously stated that the lighter oils, such as benzoline or naphtha, might be rendered safe for use in lamps by adding alum, sal ammoniac or camphor to them, and many innocent persons have suffered in consequence of their belief in the efficacy of these substances. Some years since† I tested the effect of these bodies by determining their solubility in benzoline, the flashing points of benzoline and commercial kerosene when treated with these bodies and when in their original state, and also the readiness with which mixtures of the oils, in the two conditions, with air could be exploded. The results showed that alum and sal ammoniac were practically insoluble in the oils and produced no effect whatever upon them; that the camphor was soluble, one gram of benzoline dissolving about 1.5 grams of camphor; that an equal weight of camphor raised the flashing point of a kerosene 12°; but that, on the other hand, the vapor of this camphorated kerosene, when mixed with air, had a lower point of ignition, and hence exploded with greater readiness than the original kerosene.

What is true regarding the use, storage

* Ding. poly. J. 241, 277 and 383; 1881.

† Proc. A. A. A. S. 33, 174; 1885.

and transportation of petroleum products holds for other easily volatile liquids. Professor Thomas Graham, in his report* on the cause of the loss of the 'Amazon' on January 4, 1852, pointed out clearly the danger in transporting turpentine, while the destruction of the 'Livadia,' of Liverpool, May 11, 1891, carrying a cargo of carbon disulphide, emphasizes the hazard attending this substance, for this heavy and very mobile liquid gives off quite rapidly at ordinary temperatures a vapor which is 2.64 times heavier than air, and which not only readily collects at the bottom of any space in which it is produced, but follows in a stream like water.

One of the more striking characteristics of the mixture which this vapor forms with air is its low point of ignition. The tiniest spark; a cinder after it has ceased to glow, or the striking together of two pieces of iron without sparking, are sufficient to determine its ignition. This property may be exhibited by plunging a glass rod heated to 231° C., (450° F.) (a temperature at which it can be touched with the bare hand) into the mixture.

The use of ether, alcohol, acetone and aldehyde, with nitroglycerine and guncotton, for the manufacture of smokeless powders, and of the esters as solvents for pyroxylin in the making of the varnishes that are largely used in household decoration, are some of the more modern forms of hazard, while the explosion at the Hotel Endicott, in New York, and at Newark, N. J., indicate what may be expected from the more extended use of liquefied air and liquefied acetylene.

Although Dr. John Clayton, the Dean of Kildare, in the sixteenth century, effected the destructive distillation of coal and collected and burned the gas from it,† it was

* Spontaneous Combustion and Explosions occurring in Coal Cargoes, Thomas Rowan, p. 40, 1882.

† Treatise on Coal Gas, William Richards, 1877.

not till 1792 that William Murdock devised the means for utilizing the substance and erected a plant at Cornwall, England, with which to light his house and office, and after several years of active agitation by the energetic promoter, F. A. Winsor, that in 1810 an Act of Incorporation was obtained for the London and Westminster Gas-Light and Coke Co., and the first installation on a large scale for lighting the streets of a city and supplying the public began, and through the ingenuity and resources of Samuel Clegg, the engineer, the devices were invented or assembled by which the practical manufacture, storage, distribution and use was successfully accomplished.

From this source the use of gas for lighting and heating extended over the world, reaching New York in 1834 and bringing in its train comfort and cheer, increased security, and added power to man, so long as the substance was confined to its proper channels and used in proper devices, but carrying also the possibility of working harm if the vigilance of its keepers was relaxed and it escaped from bounds; therefore beginning with the explosion at the lime purifier of the Peter Street Station, London, in 1814, through which Mr. Clegg was injured and two 9-inch walls thrown down, we have a vast army of explosive accidents originating in the ignition of mixtures of illuminating gas with air.

Owing to the circumstances attending some of these explosions there has arisen a vulgar opinion that illuminating gas is an explosive; in fact, in a recent case* counsel cited opinions of courts deciding 'gas' to be explosive; yet every chemist knows that it is not explosive *per se* and that it cannot even be made to ignite unless in contact with air or other supporter of combustion.

While we know the truth and may be able to demonstrate the fact, it is very satis-

factory to be able also to cite the results of experience on a large scale; therefore the following from the *Journal of Gaslighting*, August 1, 1871, may be welcome. It appears that at the bombardment of Paris the Governor of the city feared that the gas holders of La Villette would endanger the fortifications. He was assured that there was not the smallest risk; that if a projectile penetrated a gas holder and set fire to the gas the latter would only burn out as a jet of flame, and that there could be no such thing as an explosion, since the constant pressure would effectually prevent any access of air. Shortly after a shell pierced the holder at Ivry and lighted the gas. There was a huge jet of flame for eight minutes; the holder sank slowly and all was over. At La Villette a shell penetrated a filled gas holder and burst in the interior without igniting the gas. At Vaugirard another shell entered, and again there was neither ignition nor explosion.

Many of the accidents from coal gas and its congeners, 'water gas,' 'producer gas,' and 'generator gas,' have been due to the escape of the gases from the interred pipes and mains from which they have reached sewers, cesspools, cellars and other enclosed places, for, though these gas conduits may be sound and tight when laid, leakage will in time be caused by the corrosive action of materials in the soil, by electrolysis, by fluctuations in temperature, by settlement in filled ground and by seismic changes.* The extent of this leakage from the mains in New York City was discussed in a Legislative investigation some nine years ago, and, while the Chemist and Health Department claimed that ten per cent. of the entire annual product or one thousand million cubic feet escaped, the gas companies' representatives denied that more than one hundred million feet were lost in each year.

* Proc. U. S. Nav. Inst. 22, 638; 1896.

* Milne, McClure's Magazine, 11, 17-27; 1896.

W. C. Holmes & Co.* give the allowed leakage as five per cent. and the average leakage as ten per cent., while H. Tobey, in his paper on 'Elusive Leakages from Mains and Services,'† which was warmly discussed by the gas association before which it was read, shows that the condition still exists, and he gives illustrations showing the danger consequent on leaving abandoned sewers in place.

Owing to the fact that Bunsen, Angus-Smith, Letheby and Durand-Claye found large quantities of methane, hydrogen sulphide, and sometimes carbon monoxide, in the gases from stagnant sewage decomposing under water, there has arisen a belief that 'sewer gas' is explosive. Simple consideration of the facts that such stagnation cannot occur in a properly constructed sewer, and that such a change does not take place in flowing sewage, is sufficient to cast doubt on the existence of such a gas. It has been completely shown by Professor Wm. Ripley Nichols, in his *Chemical Examination of Sewer Air*,‡ as the result of his own extended observations, and from the discussion of numerous data by other investigators, that sewer air differs from ordinary air only in containing a larger percentage of carbon dioxide, and that 'sewer air is neither inflammable nor explosive.' The air of vaults and cesspools is, of course, a different thing, as the material in these may become stagnant.

It was as early as 1819 that an English patent was granted to David Gordon and Edward Heard for compressing gas in strong copper or other vessels fitted with ingenious reducing valves for regulating its rate of emission; 30 feet of gas being compressed into a volume of one cubic foot, and gas so compressed in cylinders of two

cubic feet capacity were conveyed to the houses of consumers, with which to operate an isolated plant. Sometimes the pressure was sufficient to liquefy the gas, and it is interesting to note that it was in the liquid from one of these reservoirs that Faraday discovered benzene.

Naturally the tension of the gas itself tends to rupture the receptacle, and many accidents from explosions of this nature have occurred owing to defects in the cylinders, or to the exposure of the filled cylinders to unduly high temperatures, or to shocks; a recent accident that could not be explained in any other way occurred at Albany, N. Y. on December 6, 1893.*

With the increased demand for compressed gases of various kinds under high tensions, such as carbon dioxide, sulphur dioxide, ammonia, chlorine, nitrogen monoxide, acetylene, air and others which are being used or introduced for commercial, scientific or domestic purposes, there is being developed a continued improvement in the strength and homogeneity of the cylinders, so that the danger from this cause is diminishing.

Although Dr. Robert Hare had invented his oxyhydrogen blowpipe in 1801,† yet in 1834 Gordon and Deville were granted a patent for their calcium or 'lime' light. It was expected by the projectors that this form of light would replace gas, as burned from ordinary burners, for lighting streets, and it caused the holders of gas securities much anxiety, but as we are now aware the device came to be used for geodetic, scientific and exhibition purposes only.

Where the gases stored in vessels are of an inflammable nature there is an additional risk to that due to the tension of the gas, since by admixture with air or oxygen an explosion occurs on ignition. One source of these accidents arises from the diffusion

* *Instructions for the Management of Gas Works*, p. 41, London, 1874.

† *Am. Gas Light J.* 64, 767; 1896.

‡ *Rept. Supt. of Sewers, Boston, Mass.*, 1879.

* *Proc. U. S. Nav. Inst.* 22, 633; 1896.

† *J. Am. Chem. Soc.* 19, 719; 1897.

of one gas back into the reservoir of another gas, but this is entirely prevented by proper regulation of the pressure and size of the orifice. Another arises from confusing the cylinders when filling them, and to prevent this the cylinders have been painted different colors. Yet, as shown by the fatal accident described by W. N. Hartley,* this has not prevented the deliberate interchange of the cylinders under the pressing demands of trade, and the usual casualty has followed. Therefore, he proposes that the fittings for the two classes of cylinders be made so entirely different that it will be practically impossible to charge the cylinder with the wrong gas, and in view of the probable increased use of gas in this form, as indicated by Mr. Thomas Fletcher,† the change should be made. Yet I doubt if it will be, except under compulsion of law, for I have learned in my efforts to introduce safety explosives in this country that the great majority will not secure the assurance of safety if this entails a little inconvenience and the taking of a little more pains.

A more common source of accident has come from impurities introduced in the making of the oxygen, as, at Nahant, Mass., where pulverized stibnite was mistaken for pyrolusite, and mixed with the potassium chlorate. Limonsin describes an accident at Cannes in 1880, which attracted unusual attention from the factitious circumstance that the gas was being prepared for the Empress of Russia,‡ and found the cause in the evolution of hydrocarbons from the rubber connecting tube by particles of heated potassium perchlorate carried into it through the turbulence of the reaction. While Professor C. A. Young gives an account§ of the explosion at Princeton while

filling a steel cylinder with oxygen by means of a water-jacketed, steam force pump, and finds the cause in oil used for lubricating the pump being sprayed into the gas cylinder so as to form an explosive mixture with the oxygen. He recommends the use of soap suds as a lubricant in place of oil. Frankland* describes a similar instance and gives a similar explanation.

Recently my attention has been called to several accidental explosions of oxyhydrogen mixtures formed in the operation of storage batteries, the detonating gas being fired by the spark formed on breaking connections at the battery.

But of all circumstances under which explosions occur the most awful are those which so frequently happen in mines, for if the miner escapes instant death it too often is but to die from suffocation, or, worse yet, to be entombed and perish from starvation preceded perhaps by insanity.

It has long been known that fire damp found its way into coal mines, and in 1674 Mr. Jessop communicated to the Royal Society a description of the accident met with by Mr. Michel, who penetrated into the gallery of a coal pit, in Yorkshire, with a naked torch and was severely burned. It is interesting to note† that, when rescued, he declared he had heard no noise, though the workmen in the vicinity had been terrified by a tremendous report accompanied by a vibration of the earth. As is to be expected, from what we now know of natural gas, inflammable gases are not confined to coal mines, but, as shown by B. H. Brough,‡ they are met with in metalliferous mines and other excavations also.

The appalling nature of these catastrophes led to efforts being made to at least reduce their frequency, if not to prevent them altogether, an extended account of these being

* Chem. News, 59, 75; 1869.

† 'On a New Commercial Application of Oxygen.' J. Soc. Chem. Ind. 7, 182; 1886.

‡ U. S. Nav. Inst. 14, 167; 1888.

§ Sci. Am., p. 369, June 11, 1887.

* Am. Gas Light J. 5, 289; 1864.

† Treatise on Coal Gas, Wm. Richards, p. 4, 1877.

‡ School of Mines Quarterly 12, 15-22; 1890.

given in Mining Accidents and their Prevention by Sir Frederick Abel, N. Y., 1889. It was early recognized that the presence of naked light was a constant source of danger, and hence the invention of the safety lamp by Sir Humphrey Davy, in 1816,* was hailed as a most beneficent gift of science, and this was soon followed by the lamps of George Stephenson and Dr. Clauny. When exposed but a short time in an atmosphere rich in gas and which is moving at a low velocity these lamps protected the miner, but if allowed to remain for some time in the gas-rich atmosphere the gauze becomes heated to the ignition point of the gas, from the gas mixture burning within it. By the introduction of ventilating appliances to remove the gas the currents of air in the mainways frequently reach a velocity of between twenty and twenty-five feet, and between two airways it may rise to thirty-five feet per second. In breaking down the coal the confined gas may rush out at a very high velocity, it being found by experiment at the Boldon Colliery that the gas may be under as great a pressure as 461 pounds to the square inch. And, finally, the air and gas may be set in motion at a high velocity by the firing of explosives to bring down the rock or coal, and more especially by a 'blown out' shot. Under such conditions the primitive safety lamps above described failed, but protected lamps have been invented which have resisted currents of even fifty feet per second for a brief period, though it is said that these are insecure in certain positions to which they may be tilted in practice, and that the glass cylinders are liable to fracture.

Instead of relying upon the safety lamps for protection a better method of procedure is to test the atmosphere of workings for the presence of fire damp before allowing the workmen to operate. Various methods have been pursued, and these are resumed

* Trans. Roy. Soc. 106, 1.

in 'The Detection and Measurement of Inflammable Gas and Vapor in Air, by Dr. Frank Clowes, 1896, London,' and he there describes a very ingenious and efficient fire damp detector which he has devised. This consists of a simple and convenient hydrogen lamp by which one can detect 1/10 of one per cent. of methane or 25/100 of one per cent. of coal gas in air. He attaches a small steel cylinder (weighing about fourteen ounces) charged with hydrogen under 100 atmospheres of pressure to the side of a safety lamp, and leads the gas through a minute copper tube up beside the wick holder of the lamp, there being a reducing valve attached to the cylinder by which to feed the hydrogen to the lamp as desired in order to control the height of the flame.

The lamp is lighted as usual at the oil wick and covered; then, when the atmosphere which it is desired to test is reached, the hydrogen is turned on and ignited, the oil flame is pricked out, the hydrogen flame adjusted to a regulation height of 10 mm. and the flame observed through the chimney against a black background. If an inflammable gas be present it will produce a pale blue cap about the hydrogen flame, and the height of this cap will increase with the per cent. of the gas in the atmosphere. By means of a scale on the chimney the height is measured and the per cent. determined.

In his experiments Clowes obtained the following:

LIMITING EXPLOSIVE MIXTURES OF VARIOUS GASES WITH AIR.

Combustible gas Percentage of Method of Kindling used. Gas in Air.

	Lower Explo- Higher Explo- sive Limit. sive Limit.		
Methane	5	13	Upward.
	6	11	Downward.
Coal gas Nottingham	6	29	Upward.
	9	22	Downward.
Water gas	9	55	Upward.
Hydrogen	5	72	"
Carbon monoxide	13	75	"
Ethylene	4	22	"
Acetylene.	3	82	Downward.

The lower 'limit' of inflammable gas represents the minimum proportion which, when mixed with air under ordinary conditions, will burn rapidly, and will, under certain conditions, produce explosions. If the proportion of inflammable gas mixed with the air is less than this in amount the mixture will only burn in the immediate neighborhood of the kindling flame, and will not burn throughout. If, on the other hand, the proportion of inflammable gas in the air exceeds the maximum 'limit' the gas will only be kindled and burn where it is in contact with an additional supply of air.

All proportions of gas intermediate between these limits are explosive when mixed with air, consequently the chance of an explosion resulting from the presence of one of these gases in the air is the greater, the more widely the 'limits' are apart, since this gives rise to the possibility of a larger number of explosive mixtures being produced. Therefore, the danger of explosion is least with methane and greatest with acetylene. Methane is a safer gas also because it has a high temperature and a slow rate of ignition. All of these conditions tend to lessen the number of colliery explosions. It is to be noted that mixtures that cannot be ignited when the flame is applied to their upper surface may be fired from below, and this is the method of firing most probable to occur in coal mines.

Few of the gases mentioned occur singly under conditions likely to give rise to danger. More commonly the combustible gases are present in a state of mixture, as in water gas and in coal gas.

In giving 'limits' it is assumed that the temperature of the mixture is not above 18°C. and that the pressure does not exceed 76 cm., for a gaseous mixture which is not inflammable under these conditions may become inflammable under increased tem-

perature or pressure, and also that a mixture that by ordinary test appears uninflammable will propagate flame if a considerable volume of gas be projected into it, owing to the resulting increase in temperature and pressure.

It will be observed that Clowes' detector reveals the presence of gas in proportions much below the danger point and gives timely warning.

The ignition of the fire damp has been frequently caused by the gunpowder and 'straw' used in blasting, for the outbursts of gas from the shaken coal and the outrush of flame and incandescent particles from the blast were often coincident. The use of electric primers and detonators remedied entirely the evils following the use of straws and naked fuse, and the employment of the high explosives gave greater immunity by reducing the frequency of the blasts. Greater security still has followed the use of the flameless explosives made from nitro-substitution compounds, or dynamites in which crystalline salts, like sodium carbonate and alum, containing a larger amount of water of crystallization, are incorporated in the mass, or water cartridges, in which the explosive in the bore holes is placed in a water bag or surrounded by moss, or other porous substances, saturated with water.

The occurrence of these mining accidents has caused the authorities grave concern, and several of the European governments, notably Prussia, France and England, have appointed many commissions, some temporary and others continuous, to investigate the reasons for the accidents and the methods of prevention. Many of the most prominent chemists of these countries have been called to serve upon the commissions, and their reports have proved not only useful in the solution of the problem in hand, but have been valuable contributions to chemical science. One of the more recent consequences of

their deliberations is the establishment at Woolwich, England, of a station for testing all explosives offered for use in coal mines, and hereafter no explosives but those which successfully pass these tests can be used, and then only in the manner minutely described in governmental authorization.*

The closer study of the phenomena of explosions in gases, consequent on these investigations, has developed many interesting facts. Bunsen found that when mixtures of hydrogen and oxygen and of carbon monoxide and oxygen in equivalent proportions were inflamed the union went on by fits and starts, and that the velocity of propagation of the reaction, through narrow orifices, was 34 meters per second in the hydrogen-oxygen mixture, and but one meter per second in the carbon monoxide-oxygen mixture.† Mallard tested various mixtures of methane and air, and coal gas and air, in the same way finding the velocity of combustion to diminish rapidly as the proportion of inert gases present increased, and obtaining a maximum speed in the case of eight volumes of air to one volume of marsh gas of 0.56 meters per second.‡

Berthelot, using tubes of 40 meters in length and 5 millimeters in diameter, obtained velocities of 2,810 meters per second for hydrogen-oxygen, 1,089 for carbon monoxide-oxygen and 2,287 for methane-oxygen,§ and found that the reaction could be propagated in three different ways: First, by combustion, as observed by Bunsen, in which the heat evolved is being continually lost through radiation and conduction, and in which, consequently, the pressure is exerted by the layer of burning molecules on their adjacent molecules, and hence their velocity of trans-

lation tends constantly toward a minimum. Second, by detonation in which the heat evolved, the pressure produced by the reacting molecules on contiguous molecules, and the velocity of translation of the explosive reaction all tend toward the maximum. And, finally, an intermediate stage; all three being marked by distinct waves. Von Octtinger and von Gernet* have, by a very ingenious arrangement, succeeded in photographing, first, a fundamental one, which they style Berthelot's wave; second, more or less parallel secondary waves, whose existence they explain on Bunsen's hypothesis of the reflex action of waves due to successive explosions produced by the electric spark, and which they style Bunsen's waves; and third, polygonal waves of smaller amplitude. They obtained a velocity of 2,800 meters per second, which is of the same magnitude as those obtained by Berthelot.

Berthelot and Vieille's experiments show that when an explosion occurs in a gaseous mixture a number of ignited molecules are projected forward with a velocity corresponding with the maximum temperature produced by the chemical combination. The impact of these molecules causes the ignition of the adjacent particles, and the rate of progression of the combustion is thus dependent upon the activity of the chemical action.

Mallard and Le Châtelier find that the rate of propagation of flame through an inflammable gaseous mixture is affected not only by the temperature and size of the igniting flame, but also by the mechanical agitation or disturbance of the mixture itself. These results are not surprising when it is considered that for the spread of combustion in an inflammable gaseous mixture it is necessary that the temperature of the combustion should be sufficient to ignite the unignited portion.

* Ann. der Phys.

* Rept. Com. to inquire into the History of Explosives for Use in Coal Mines, London, 1897.

† Ann. Chim. Phys. (4) 14, 449.

‡ Ann. de Mines 8, 1871.

§ Sur la force de la poudre, 1, 153.

Dr. W. H. Birchmore* has devised an apparatus for firing gaseous mixtures which shows many of those phenomena. He uses two large bulbs connected by a tube of determined dimension for his explosion chamber and a large tin foil condenser for igniting the mixture, and he finds the phenomena to be different from those observed in tubes ignited in the ordinary way. The reaction takes place more promptly and sharply, and when using hydrogen and air in variable amount not only is some of the oxygen ozonized, but hydrogen dioxide is produced with the water of the reaction.

When using acetylene, with sufficient air to consume it theoretically, some of the carbon is separated out in the solid form, although free oxygen was found in the residues, and it was not until he had reached eight times the volume of air required by the theory that he got the theoretical amount of carbon dioxide.

He also describes a form of experiment which very cleverly illustrates the successive phenomena occurring in the acetylene explosion at Paris.

The minimum volume of an inflammable gas which forms an explosive mixture with air is very considerably reduced if fine dust is present in the air. Buddle directed attention some 90 years ago, in an account of the Wallsend Colliery explosion, to the destructive effect produced by the ignited coal dust at a distance from the point of first explosion. Robert Bald, in 1828, pointed out† that the blast of flame from a fire-damp explosion might ignite the coal dust on the floor of the pit. Faraday and Lyell, in their report on the Haswell Colliery explosion of September, 1844,‡ demonstrated that coal dust may be instrumental in greatly extending and in increasing the disastrous effects of fire-damp explosions.

Abel* has shown that the presence of finely divided incombustible mineral matter in air containing less than 2 per cent. of fire damp causes the latter to become explosive on ignition, and Galloway has proved that a mixture of air containing less than one per cent. of fire damp can be made to explode when charged with finely divided coal dust. I have applied this observation of the effect of the dust in facilitating explosions to lecture experiments with inflammable gaseous mixtures.†

The explosion at the Capitol on November 6th was confined to that portion of the building known as the Supreme Court section and which joins the Senate wing to the central structure. In the center of this section is a dome which is rarely noticed, as it is completely overshadowed by the central dome of the Capitol. This dome is supported in the sub-basement on piers, while all about these piers are brick vaults and arches of varying heights, carrying the many partition walls and floors above them, and these, with those radiating from under the big dome and the connecting passages, form a perfect labyrinth. The complexity is increased by several of the spaces having been enclosed with brick walls so as to carry steam-heating coils and for other purposes. A large part of the wall space had been fitted with shelving, and these were filled to overflowing with pamphlets. One space was used as an engine room, from which to operate a Sturtevant blower that fed air over the coils. This engine was provided with a woven guard screen to protect passers-by, made from 5/16-inch wrought-iron rods, riveted on each edge into two wrought-iron bars, each of which was 7/8 inches wide by 7/16 inches thick. Directly opposite this screen and leading south was a low, narrow passage that opened into one of the largest and highest of the vaults, in which was stowed, in the open spaces be-

* *Am. Gas Light J.* 67, 563-565; 1897.

† *Ed. Phil. J.* 5, 101; 1828.

‡ *Inst. C. E. Tracts*, vol. 284.

* *Accident in Mines*, *Proc. Inst. Civ. Eng.*, 1898.

† *Proc. U. S. Nav. Inst.* 12, 429; 1896.

hind two supporting walls or piers, the ash from the wood fires which were burned in the rooms above. These hickory ash pits, as they were styled, were south of and directly in line with the passage leading toward the iron screen. This series of compartments was on the extreme west of the sub-basement. A few of the exterior compartments of the sub-basement received a very little daylight, but all the rest was wholly dependent on artificial light and several gas jets were kept constantly lighted. In the center of the sub-basement, under the dome, was a large gas meter connected to a 4-inch main and having on its outlet end a 200-light glycerine gas governor. This meter had not been in use for some time, and the inlet valve was closed, but the outlet valve was open, and it was discovered afterwards that this outlet pipe was also connected with a live 4-inch main. The explosion occurred about 5:15 p. m., and its effects were observed over 47,000 cubic feet of the basement and upward quite to the dome. By the explosion the brick arches, covered with earth and then with heavy stone pavement slabs, were torn up, brick partitions and supporting walls were overthrown, stout locked doors on the upper floors were torn open, and there was a general wrecking of all the lighter structural parts. Observation of the lay of the wreckage showed conclusively that it radiated in all directions from a point about the gas meter, and that the most violent effects were in general at the points most distant from this center. The most violent effect of all was on the west, where the heavy granite screen wall forming the façade of the building was displaced by $1\frac{1}{2}$ inches, and the stout wire protecting screen about the engine was forced into a depth of two feet from the original plane for an area of three feet in diameter, and many of the stout rods were ruptured. Searching examination showed that no ex-

plosive or other explosive-forming material than illuminating gas could have been present; that for thirty minutes prior to the explosion there was for some reason a gas pressure of twice the normal; that under an excessive pressure gas would flow through the governor, and that this could furnish sufficient gas to do the work accomplished.

The gas had a specific gravity of 0.601, and as it escaped it flowed through the devious passages and compartments, filling first the pockets with mixtures of various proportions and settling lower and lower until the stratum reached down to the level of the burning gas jets where it was fired. These were near the meter, where, of course, the gas would be richest. Here was the region of combustion. As the tongue of flame rushed under the low archways and through the passageways to the higher vaults beyond, it produced a violent disturbance of the atmosphere, thoroughly commingling the gas and air and throwing a mass of inflamed gas into their midst, thus producing a greatly accelerated combustion and explosion. When this tongue of flame burst into the compartment containing the hickory ash this dust was also intimately commingled with the gas-laden atmosphere, and here was produced the most violent of all the effects manifested; for the granite screen wall that was displaced was on the right side of the hickory ash pits, and the stout wire screen that was perforated was directly in front of them and at the end of the low and narrow passage leading from the vault containing these pits; and further the most violent effects produced on the upper floors, quite to the top of the building, were about the spiral staircase leading from the compartment containing the wire screen and which was but a continuation, through the low, narrow passages of the compartment containing the hickory ash.

CHARLES E. MUNROE.

COLUMBIAN UNIVERSITY.

AMERICAN MORPHOLOGICAL SOCIETY.

II.

A Case of Egg Within Egg. F. H. HERRICK.

A SMALL egg of the fowl, measuring 21 by 17 mm., was taken from the yolk of an apparently otherwise normal egg. The included egg possesses a hard shell, shell membrane, albumen and yolk. Various kinds of inclusions belonging to this type have been recorded in the domestic fowl due to fusion of two egg-like bodies in the oviduct of the hen. Small eggs of this character are sometimes laid. They sometimes contain albumen and no yolk, and probably never have a blastoderm. The idea has already been expressed, and is apparently well founded, that the small egg represents the fragment of a normal egg which was ruptured and threw off a part of its substance at the time of leaving the ovary, such fragments being treated in the oviduct like full-sized ova.

Secondary Abdominal Pregnancy with Histolysis of the Fetus. F. H. HERRICK.

THE case reported occurred in the cat, where rupture of the uterus, leading to intra abdominal birth, had resulted in the following conditions: (1) Abnormal development of peritoneal structures (thickenings, adhesions, fenestration of the membranes, and tag-like outgrowths over them); (2) fragmentation of the fetus, and attachment of the parts to the omenta by overgrowth, the result of extensive proliferation in the constituent cells of these membranes; (3) the more or less complete replacement of the soft embryonic tissues by the proliferating cells.

On the Early Development of Cerebratulus. W. R. COE.

THE processes concerned in the maturation and fertilization of the ovum of *C. marginatus* agree closely with those which have been described by Kostanecki and Wierzejski for *Physa*, and by Child for *Arenicola*.

The centrosome arising from the spermatozoon divides early. The division of its aster is accompanied with the formation of a delicate central spindle. The spermasters eventually degenerate, although their rays often remain even after the cleavage-asters have appeared. Their centrosomes usually become lost to view. Occasionally, however, it can be demonstrated, with a good deal of certainty, that they do not actually end their existence, but retain their identity and become the centers of the cleavage asters.

The centrospheres of the cleavage asters increase enormously in size. They are not artifacts, for they may be seen in the living egg. The centrosomes are very minute. They divide early, and the asters of the second cleavage begin to form about them quite within the body of the centrosphere, as in the *Thalassema*.

The eggs of *Micrura caeca* and *Cerebratulus leidy* furnish almost ideal examples of the regular spiral type of cleavage. The first two cleavages are almost exactly equal in size. In the third division the upper four cells are slightly larger than the lower four. A very regular blastula results. The marked backward inclination of the enteron is evident from the very beginning of gastrulation.

At the end of the first day the enteron becomes divided into two distinct regions. Pseudopod-like processes of cells grow out to separate the two cavities and almost completely. The posterior blind sack of columnar cells is not definitely cut off from communication with the exterior, however, and food may enter by a temporary opening between the cell-processes.

Large cells of the larval mesenchyme, which wandered into the segmentation cavity at the beginning of the gastrulation, multiply rapidly and arrange themselves in certain definite positions, as in *C. lacteus*. Most of them send out branching and

anastomosing fibrous processes, which become attached to the adjacent wall of the body, or of the enteron, to form the larval musculature. The others remain as parenchyma cells.

Fission and Regeneration in Cerebratulus. C. B. WILSON.

For three years, while investigating the embryology of *Cerebratulus lacteus*, Verrill, very few perfect specimens were found at the close of the breeding season, while there were many with regenerating papillæ. Last summer a perfect male and female were secured and kept for ten weeks. The genital products were discharged simultaneously three different times at intervals of several days. Then both worms dismembered the posterior half of their bodies without provocation.

The anterior fragments at once regenerated, growing in three weeks' time papillæ measuring 50 mm. in the female and 38 mm. in the male. The posterior fragments lived ten days and died without any signs of regeneration. But others have been kept alive several weeks under less favorable conditions and have yielded perfectly healthy sexual products. We are led to conclude, therefore, that *Cerebratulus* often dismembers voluntarily at the close of the breeding season, but, while the anterior fragments regularly regenerate, the posterior ones seldom if ever do so. Careful anatomical examination shows that actual fission is accomplished chiefly by means of the transverse muscles of the body-walls. There are no indications of the rows of nuclei found by Blenham in *Carinella*.

Sections of papillæ show that in regeneration the longitudinal muscles contain numerous transverse fibers; in the early stages the two kinds are about equal.

The large lateral nerve cords are regenerated from ectoderm cells. Two parallel longitudinal invaginations appear on the

ventral surface of the papilla. The ectoderm between them contains no gland cells: a shallow longitudinal groove soon separates this ectoderm into halves. In the center of each half nerve fibers are formed from modified ectoderm cells.

They then migrate to their normal position, while both groove and invaginations quickly disappear and the ectoderm becomes filled with gland cells.

The Female Genital Tract in Melophagus. H. S. PRATT.

MELOPHAGUS OVINUS, a dipterous insect, is peculiar because of the unusual length of its uterine life, the young animal being born as a fully grown larva. This long uterine life has been the cause of a profound modification of the entire genital tract. The uterus is unusually large; two pairs of glands pour a milk-like food into the uterus which feeds the growing larva; the proximal portions of the oviducts are fused and function as a permanent receptaculum seminis; the ovary possesses a very thick peritoneal covering composed of branched muscle and connective-tissue fibres which forms a sac and encloses the two ovarioles; these are composed each of two follicles and a germarium, no terminal thread being present, and are attached by the germarium to the inner distal surface of the peritoneal sac, their lower ends hanging free within the sac. There are thus in the two ovaries at any one time eight follicles, each containing a developing ovum. A single egg is produced every two to four weeks; it passes into the uterus, being fertilized on the way, and there remains two to four weeks until the young animal is born, an old larva. The two ovaries, and within each ovary the two ovarioles, alternate in furnishing the next egg.

Intracellular Differentiations in Gland Cells of Phascolosoma Gouldii. MARGARET LEWIS NICKERSON.

IN the epidermis of this Gephyrean are

found several well-marked forms of epidermal organs, one of which is characterized by the presence of intracellular sacks or ampullæ leading into anastomosing canals. Such organs contain both sensory and glandular cells, but in the gland cells alone are found the intracellular sacks.

These organs present several well-marked conditions corresponding with different stages of functional activity. One suggestive condition shows the following details of structure. In the upper part of each gland cell are two sacks lying one within the other and separated by a considerable space. This intervening space is traversed by many delicate filaments connecting the walls of the two sacks. The inner sack becomes continuous at its outer end, with a narrow canal, while the outer sack is continuous with a sheath surrounding this canal. The several canals unite to form larger canals, and there finally results one main duct opening to the exterior. This duct is surrounded by a broad sheath, which is a continuation of the sheaths enveloping the ampullæ and primary canals. By the side of the main duct, within its enveloping sheath, is a large nucleus surrounded by a clear area, which probably represents a vacuole. Regarding this nucleus the ampullæ, canals and sheaths the following hypothesis is offered. The sheath of the main duct and its branches, including the radial vesicles surrounding the ampullæ, together constitute a cell of very irregular shape, a cell which in form may be compared to a bunch of grapes with its stem. This single cell contains the main duct, its branches and their terminal ampullæ, and itself reaches down flask-shaped processes containing the ampullæ, which are embedded in the outer ends of the surrounding gland cells. The walls of the outer sacks, and their continuations as the outer wall of the sheath, represent the boundary of this highly differentiated cell.

The Development of the Adhesive Organ of Amia. JACOB REIGHARD. (Presented for Miss Jessie Phelps.)

THE adhesive organ of *Amia* consists of a pair of semicircular or sausage-shaped ridges forming together an incomplete ring on the end of the snout of the young larva. Each ridge is a row of six to eight epithelial cups which open on the surface of the snout. Their cells secrete a mucus by means of which the animal attaches itself.

The organ is formed in a very early stage as a diverticulum of the fore gut. This diverticulum subsequently divides into two, each of which continues to communicate for a time with the cavity of the foregut.

Each of the two diverticula later separates from the foregut, becomes elongated and curved into the form of a semicircle and divides into from six to eight closed vesicles. The vesicles finally open to the exterior and are thus converted into cups.

After being functionally active for a time the organ is pushed beneath the surface by the thickening ectoblast, becomes infiltrated with leucocytes, and finally disappears (larvæ of 20 to 25 mm.) without leaving any trace behind it.

The integumentary sense organs appear in the neighboring ectoblast, quite independently of the adhesive organ.

Dean's comparison of the cups of the adhesive organ with the integumentary sense organs is thus seen to be untenable.

Notes on Loxosoma Davenporti. W. S. NICKERSON.

A PAIR of flask-shaped glandular organs is commonly present in the American species of *Loxosoma*, attached by their broader rounded ends nearly opposite the lower end of the stomach, one upon each side. Each consists of a central core of 4 or 5 glandular cells and a peripheral layer of flattened epithelial cells continuous with the epithelial body-covering of the animal. The gland

cells have basal nuclei and cytoplasm filled with fine granules; their distal ends extend outward to a minute pore at the extremity of the flask. After the discharge of their contents the central cells appear shriveled, and it is probable that the whole organ is soon afterwards lost. Individuals lacking one or both flask-organs are frequently observed. After being lost, the structure is reformed in the same position. It arises as a conical thickening of the ectoderm, of which the central cells take on a glandular function, and the lateral ones form the epithelial covering. Similar organs have not been described as occurring in any other endoproct. The function of their secretion is unknown.

On the outer surface of each tentacle just at the margin of the lophophore there is a single large cell which forms a slight protuberance. Its nucleus is large and situated near the deeper surface; the cytoplasm shows a number of delicate lines extending through it perpendicularly toward the free surface, which is covered by a thickened portion of the cuticula, having the form of a flattened disk or of a saucer with its concave surface outward. The observation of the living animal shows that these structures are unicellular suckers or organs for attachment by means of which the little creature fixes itself by the margin of its expanded lophophore while changing the position of its foot attachment.

The reproductive system of *L. Davenporti* presents the rare condition of protogynic hermaphroditism. Both kinds of sexual products arise in the single pair of gonads, the ova being formed before the sperm. The evidence for this consists in finding in the same individual a functional ovary on one side of the body, while the gonad of the other side contained, together with an evidently degenerating ovum, a mass of cells showing various stages of spermatogenesis up to the mature sperma-

tozoa with tails. Animals which are functionally males are relatively few during the summer months.

Buds remain attached to the parent till well matured. They vary in number from 1 or 2 to 12. Abnormal buds lacking tentacles, digestive organs, reproductive system, etc., are not infrequently present. They consist of a small rounded body borne on a slender stalk. The proximal side of the lophophore margin forms a blunt projection against which the rest of the margin can be opposed, thus closing the atrial cavity. The epithelium lining the atrium is composed of large glandular cells. The relation of these buds to the parent is not different from that of the normal buds, nor does their attachment persist longer. They appear to be incapable of leading an independent existence and have no known function. They are probably manifestations of a tendency to produce modified members of the colony comparable with the avicularia of certain Ectoprocta, a tendency derived from stock-building ancestors and which has not yet been eliminated. According to this hypothesis we must regard the non-colonial habit of life of *Loxosoma* as secondarily acquired, perhaps in adaptation to its semi-parasitic or commensal mode of life, not, as has been assumed heretofore, as a primitive condition.

Embryos are present, attached to the 'mammary organ' of the parent during July and August. On the embryo a pair of buds arise very early and are fully formed by the time it becomes free from the parent. Soon after the buds separate from it the embryo perishes without undergoing a metamorphosis.

On the Motor Reactions of Paramecium. H. S. JENNINGS.

THE paper was an analysis of the mechanism of reactions to stimuli in the ciliate infusorian *Paramecium*. To all classes

of stimuli *Paramecium* responds with the same motor reaction, in greater or less intensity. The direction of motion after a stimulus is determined by the structure of the animal's body and has no relation to the localization of the stimulus. *Paramecia* are not directly attracted by any agent; they collect in the regions of certain conditions merely in virtue of the fact that these conditions cause no motor reactions, while the surrounding fluid causes a motor reaction that results in random movements, which must (through the laws of chance) eventually bring the animal into a region where these motors cease.

Phototaxis of Daphnia. C. B. DAVENPORT and F. T. LEWIS.

THE problem is to determine the dependence of the degree of phototactic sensitiveness upon preceding conditions of illumination. Other conditions being similar, do *Daphnia* reared in the dark respond to a fainter illumination than those reared in the light? Special apparatus afforded a quantitative answer to this question. *Daphnia* reared in half-darkness moved, on the average, nearly three times as far toward a light of about minimal intensity as did *Daphnia* reared in the light. We may conclude: Those individuals reared in the dark have become attuned to a lower intensity than those reared in the light.

The minimum intensity inducing phototaxis was, in the more sensitive *Daphnia*, 0.002 candle power at a distance of 3.5 meters, or $\frac{0.002}{3.5^2} = 0.00016$ meter candles.

The phototropic sensitiveness of *Daphnia* is quite equal to the phototropic sensitiveness of the most sensitive seedlings.

Early Development of Pennaria Tiarella. CHAS. W. HARGITT.

THE egg of *Pennaria* is of relatively large size and heavily yolk-laden. In color it is of a light orange or pinkish hue. It is

of ectodermal origin and grows by an active absorption of other ovarian cells. The egg is discharged almost immediately upon the liberation of the medusa, which takes place during the evening from seven to ten o'clock. Fertilization occurs very soon after the egg is discharged, or possibly in some cases before, since in many specimens the medusae are never liberated, and the eggs seem to be discharged with difficulty and not infrequently exhibit segmentation phases while yet within the bell of the medusa. But so far as I have been able to note, the sperms always gain access to the egg from the outside.

The extrusion of the polar globules is only rarely to be noted, but occurs in an altogether normal way. Segmentation begins usually within fifteen minutes of the access of the spermatozoon. The first cleavage is usually into fairly normal two-celled forms, but seldom exactly in the same way, perhaps no two eggs exhibiting the same cleavage features. This is peculiarly the case in all the later phases. It is absolutely indeterminate and remarkably irregular and erratic. So much so was this that during the first series of observations the whole lot were discarded, as probably for some unknown reason abnormal or pathological. A second series taken the next night behaved in the same way, and while still thought to be somewhat abnormal were followed through to the completion of the irregular cleavage, and were found the following morning to have become perfectly normal planulae.

That they were genuine cleavage phenomena was conclusively proved by sections of the various stages and the demonstration of mitotic figures in all phases of growth and decline.

Somewhat similar though incomparably less marked phenomena had been noted long ago by Wilson in the development of *Renilla*, and by Metschnikoff in *Rathkea* and

Oceania, and, incidentally, by Bunting, in *Hydractinia*. The most nearly comparable observations, so far as I have been able to discover, are those recently reported by Andrews in *Hydra*.

This work was begun at the Marine Biological Laboratory in 1897, continued during 1898, and is still in progress. It is hoped that a fuller account, with definite illustrations, may soon appear.

Grafting Experiments upon Hydromedusæ.
CHAS. W. HARGITT.

IN course of previous work upon regeneration among the Hydromedusæ, the problem of grafting was forcibly impressed upon me, and during the summer of 1898, at the Marine Biological Laboratory, was undertaken and followed up during nearly two months, and with results as briefly outlined below.

It was undertaken to show the practicability of uniting sections of different individuals, different species and even genera.

The first work undertaken was upon Hydroids, chiefly Tubularians, *e. g.*, species of *Eudendrium*, *Pennaria*, *Parypha*, *Clava*, with only one series of experiments upon a Campanularian. The latter was for some reason almost wholly negative in results. In all the former the results were unusually successful, no less than 10% responding within the limits indicated. To merely summarize:

1. No difficulty was found in securing perfect union between segments of the same species in from twelve to twenty-four hours. A delicate sheath of perisarc overlapping the proximal ends was first secreted, and this was followed by organic union of the cœnosarc of the hydroid. The grafting was equally successful whether made by oral, aboral or alternating contact of the segments. Abundant heteromorphism was secured along with the other results. 2. It was equally easy to secure union of

male and female specimens of the same species. 3. If the distinctness of Agassiz's species of *Eudendrium dispar* and *ramosum* is to be maintained—a fact which has seemed to me doubtful—then there was secured a ready grafting of different species. 4. In no case was I able to secure successful grafting between different genera. This was tried repeatedly with several, but in each case with negative results.

The second problem undertaken was upon the medusæ. The most accessible form was *Gonionemus vertens*, and the results obtained were on this form alone. Grafting was made possible only by the expedient of paralyzing the specimens by emargination of the entire bell, thus removing the coordinating centers. This done, there was no more difficulty in securing perfect union of different portions of the body than with the hydroid forms. It mattered little from what portion of the body taken, or in what relation placed, perfect union was usually secured in from 24 to 48 hours. Two medusæ grafted orally recovered nervous activity, and even exhibited a definite coördination, the double medusa acting as one.

The Life-History of Dicyema. WILLIAM
MORTON WHEELER.

A STUDY of the Dicyemidæ (*Dicyema coluber*, n. sp.; *Dicyemennæa Whitmanii*, n. sp., and *Dicyemodæca sceptrum*, n. gen. et n. sp.), parasitic in the kidneys of the West Coast *Octopus* (*O. punctatus*), was undertaken with a view to answering the following questions concerning the life-history of these animals: 1. What are the relations of the nematogenic and rhombogenic individuals to each other? 2. What is the meaning of the so-called infusoriform embryo? 3. What is the meaning of the infusorigen? An examination of the parasites of one hundred *Octopus* of different ages led to the conclusion that the Dicyemidæ first reproduce as nematogens for several generations, but that

ultimately the same individuals become rhombogens and thenceforth produce only infusoriform young. Certain Dicyemids were found to contain both vermiform and infusoriform young. E. Van Beneden's view, that the infusoriform is the male Dicyemid, was confirmed by a study of its structure and a comparison of this form with the male Orthonectid (*Rhopalura*). From the fact that deeply staining bodies resembling the granules of the urn of the infusoriform, and probably for that reason spermatozoa were found among the germ-cells of the infusorigen, it was inferred that the infusoriform young may arise from fertilized ova, and that the infusorigen may be an adaptation for accumulating the germ-cells around a central cell to which the spermatozoa are also attracted, possibly by chemotaxis. It was regarded as probable that both the male (infusoriform) and female Dicyemid migrate into the kidneys of the young *Octopus* and there form colonies of nematogenic females before males are produced.

Notes on the Blind Fishes. C. H. EIGEN-MANN.

1. THERE is a color pattern common to all the species of the Amblyopsidæ. This pattern is due to the arrangement of the chromatophores along the connective tissue septa separating successive muscle segments. The result is a series of longitudinal stripes where the septa are bent on the surface and a series of zigzag cross streaks. This pattern is best marked in *Chologaster agassizii*, in which but little color is present. It is somewhat obscure in *Chologaster cornutus* on account of the great development of pigment. It remains only as an arrangement of chromatophores in the blind members of the family where color is no longer present in sufficient quantity to be evident to the naked eye.

2. *Chologaster agassizii*, which has so far been known from the type only, was secured

through a grant from the Elizabeth Thompson Science fund. It is a species with well developed eyes living permanently in caves. Its eye is notably smaller than that of the other species of *Chologaster* which live in open waters. The retina is very much like that of *C. papilliferus*, with thinner pigment layer. The eyes of the species of *Chologaster* show the following measurements:

C. papilliferus, 32 mm. long. Vertical diameter, .832 mm. Longitudinal, .880 mm.

C. agassizii, 39 mm. long. Vertical diameter, .720 mm. Longitudinal, .800.

C. cornutus, 32 mm. long. Vertical diameter, .960 mm. Longitudinal, 1.120.

Thickness of the retina of

C. papilliferus, 29-34 mm. long, .122 mm., 55 mm. long, .162 mm.

C. agassizii, 38 mm. long, .107 mm., 62 mm. long, .130 mm.

C. cornutus 27 mm. long, .73 mm., 43 mm. long, .83 mm.

3. The blind fish from Missouri is of different origin from the blind fishes east of the Mississippi. The details of this part of the paper have appeared in SCIENCE.

Regeneration and Regulation in Hydra viridis. HERBERT W. RAND.

IN a series of regeneration experiments upon *Hydra viridis* it was found that the polyps regenerate, on the average, fewer tentacles than are originally possessed. The more tentacles before regeneration the greater is the mean number after regeneration. Eight-tentacled *Hydras* showed the greatest reduction in the number of tentacles. Six-tentacled *Hydras* showed no reduction.

The average deviation from the mean was practically the same before and after regeneration. The average deviation from the mean after regeneration, and also the average deviation from the original number, was greater in the eight-tentacled groups and least in the six-tentacled.

The mean number of tentacles regenerated by whole six-tentacled *Hydras* was

6.0; by halves of six-tentacled *Hydras*, 4.6; by quarters of six-tentacled *Hydras*, 3.8. Of *Hydras* having the same number of tentacles the larger *Hydras*, or parts of them, regenerate more tentacles than the smaller ones or corresponding parts of them. *Hydras* cut longitudinally into pieces of equal volume, but bearing different numbers of tentacles, regenerate as many tentacles as are required to complete a normal number.

In the regeneration of a small fragment of hypostome with tentacles attached, one tentacle became thickened to form the body. Often in the regeneration of whole 'heads' a tentacle whose axis came to lie approximately in the axis of the body apparently became thickened to assist in the downward extension of the body.

In 'heads' severed immediately below the tentacles forms of very abnormal appearance resulted in the process of closing the wound. Abnormalities, consisting in tentacles abnormally placed and in unusual numbers of oral tentacles, persisted for a considerable period. Regulative processes resulted in the degeneration of abnormally placed tentacles and in the establishment of a normal number of oval tentacles. Tentacles but slightly displaced from the circum-oval ring were shifted back into it.

The regenerative and regulative processes are directed toward the regaining of a perfectly normal form.

Notes on the Actinians of Bermuda. A. E. VERRILL.

On the Atlantic Palolo Worm. A. G. MAYEE.

The Origin of Blood Vessels in the Chick. L. H. SNOWDEN.

The Evolution of the Color Pattern of Columba livia from that Preserved in C. affinis Blyth. C. O. WHITMAN.

BASHFORD DEAN,
Secretary.

STALACTITES OF SAND.

IN Mr. Rose's black-sand gold mine, on the Oregon coast, about fifteen miles south of Coos Bay, are some curious stalactites of sand which deserve attention on account of their exceptional character.

The mine is along an ancient beach about 160 feet above the sea level and nearly two miles distant from the present shore. The black sand in which the gold occurs rests directly upon the upturned and eroded edges of Tertiary shales. It is about 100 feet in width and four feet in thickness, and is overlain by about thirty feet of horizontal Pleistocene sand beds with some gravel. These have to be removed before the black sand can be reached. The black sand at this point is composed chiefly of garnet, with a number of other heavy ferromagnesian minerals. It is partially cemented by oxide of iron, but may be readily crumbled in the hand.

The gray sand by which the black sand is immediately overlain is composed chiefly of quartz, but contains also many grains of feldspar besides those of other minerals and rocks. In some places this gray sand is cemented so firmly as to form a friable sandstone, and when the black sand is removed from beneath the exposed under surface of the sandstones is found to be covered with stalactites of sand. The cross bedding in the sand dips gently to the west. The stalactites incline westward at the same angle, forming only a small angle with the surface to which they are attached. The forms of the stalactites are well developed; some are small, others nearly a foot in length. Most of them are single, but a few are double, as if two were united in their development. There is no sign of a tube down in the center, as in the case of many stalactites of carbonate of lime.

The cementing material by means of which the sand is held together, making these curious forms, is not soluble in acid.

In a thin section under the microscope it is seen that each grain of the sand is surrounded by a thin coating of crystalline quartz which fills the small interstices and binds the whole together.

It seems altogether probable that the solutions bearing silica followed the porous layers of sand in the cross bedding, but what determined its deposition through the sand in the shape of an icicle is not so easily understood. It is not impossible, although quite improbable, that wind erosion had anything to do in developing these forms. The stalactites exposed in the mine were not so situated as to be attacked by drifting sand. Their local character is scarcely less difficult to explain satisfactorily than the peculiar forms themselves.

J. S. DILLER.

U. S. GEOLOGICAL SURVEY,
WASHINGTON, D. C., February 18th.

SCIENTIFIC BOOKS.

Degeneracy: Its Causes, Signs and Results. By EUGENE S. TALBOT, M.D., D.D.S. The Contemporary Science Series. London, Walter Scott, Limited; New York, Charles Scribner's Sons. 1898. Illustrated.

The busy reader who has dipped into the works of Morel, Lombroso, Nordau and other writers upon degeneracy, and who has become, perhaps, somewhat confused by conflicting opinions and sweeping applications of this interesting biological doctrine, will receive with delight this calm and dispassionate as well as condensed 'conclusion of the whole matter' (up to date). The plan of the book is good, giving as it does a brief survey of the whole subject from its historical, biological, psychological and pedagogical points of view. The author, too, is well prepared for his task, having a wide dental and medical experience, and, particularly, a most extensive acquaintance with the literature of the subject, especially of that literature which is most valuable here, viz., that of the medical and biological journals. This gives the book a healthy inductive tone. The author spends no time in the discussion of

theories of his own or of others. He gives us rather a summary of facts relating to the antecedents and the symptoms of degeneracy in all its forms. Of the eighteen chapters some of the most interesting are the ones on heredity and atavism, consanguineous and neurotic intermarriages, toxic agents, school strain, degeneracy of the brain and degeneracy of mentality and morality. In the chapter on heredity and atavism the summary of the accumulated evidence against Weismannism is rather striking.

In a series of chapters the author discusses the causes of degeneracy. Among these, contagious and infectious diseases, led by tuberculosis, syphilis, typhoid fever, scarlatina, small pox, measles and diphtheria, are the most prolific. Other leading causes are toxic agents, such as tobacco, alcohol, opium, tea and coffee, insufficient or impure food and unfavorable climate, and, finally, school strain among children. The immediate consequence of these agents is nervous exhaustion in the first generation. The offspring of these neurasthenics do not possess the necessary vitality to carry them through the normal process of development. The result in the second generation is arrested development of the nervous centers and degeneracy of bodily structure, exhibited in the form of reversionary tendencies. Very full descriptions of the various stigmata of degeneracy follow. Among them are local reversionary tendencies, such as anomalies of skull, jaws, teeth, ears, etc.; nutritive degeneracy, shown in cancer, gout, goitre, adenoids, plural births and excessive fecundity; sensory degeneracy, such as deaf-mutism and congenital color-blindness; intellectual degeneracy, such as paranoia, hysteria, epilepsy, idiocy and one-sided genius; and ethical degeneracy, such as crime, prostitution, pauperism and inebriety. Degeneracy caused by alcohol is less dangerous to the community than that caused by opium and by various contagions and infections, since, owing to its deteriorating effects upon the reproductive organs, it tends to exterminate itself. This non-survival of the unfit is by no means true of all forms of degeneracy. Healthy atavism, however, is always at work and tends to counteract the immediate results of heredity.

Consanguineous marriages are not in themselves, in perfectly healthy stock, causes of degeneracy, but where degeneracy has begun, such marriages, of course, accelerate its action.

The book closes with a chapter on the prevention and treatment of degeneracy. The author is not an advocate of heroic methods, such as the legal regulation of marriage and other still more certain methods of checking its transmission. He proposes milder means, particularly rational forms of prophylaxis adapted to circumstances and to individuals.

G. T. W. PATRICK.

UNIVERSITY OF IOWA,
IOWA CITY.

A Synonymic Catalogue of the North American Rhopalocera. By HENRY SKINNER. American Entomological Society, December, 1898. Pp. xiv+100.

The catalogue of North American butterflies published by Mr. W. H. Edwards in 1884 listed 612 species from the United States and Canada. The new catalogue, now before us, enumerates 645; the moderate number of additions in about 14 years of great activity among lepidopterists indicates that our butterfly fauna is fairly well known. The additions are in reality somewhat more numerous than the figures cited indicate, owing to the rejection of some of the names of the earlier list; but there is no tendency to 'lumping' exhibited, which is rather surprising in consideration of some of Dr. Skinner's previously expressed views.

The literature is cited very fully, though we notice a few omissions, such as that of Edwards' account of the larva of *Lycæna exilis*. The genera are nearly as in the Edwards catalogue. It is to be regretted that *Pamphila* is still made to include a great number of forms, belonging to numerous genera; but it is certainly true that the best generic arrangement which could be offered at the present time would be largely provisional.

An examination of the catalogue recalls and emphasizes certain interesting features of our butterfly fauna. Certain portions are of tropical origin, while other groups belong to what has been called the holarctic region. In the tropics conditions have been relatively uniform

for ages, and in consequence we have a large number of organisms in a condition of considerable stability—in other words, 'good species.'

The writer has found, when working with Coccidæ, that the tropical species are, as a general rule, much more easily separated than those of temperate regions. The same is true, apparently, among the butterflies. Take the Hesperidæ and Lycænidæ, which are so numerous in tropical America. The tropical groups of Hesperidæ, in particular, have largely invaded the United States, and very many species have been catalogued. Now Dr. Skinner himself has told us in another connection that these species are, as a rule, well-defined, though frequently superficially similar. But there is one characteristically holarctic series of Hesperidæ—the series of *Pamphila comma*—and here at once we meet with innumerable local races or weak species, with difficulty to be separated from one another. So in *Lycæna* the holarctic group of *pseudargiolus* and its allies is especially polymorphic. When we come to the typically holarctic genera, such as *Argynnis*, we find a wilderness of plastic forms, which may be called species or varieties according to the taste of the student.

It thus happens that for the evolutionist temperate regions, lately subject to glacial desolation, are in many respects more interesting than the luxuriant tropics. Here, especially, are species in the making; here is Nature's kitchen and the cook at work. In the tropics, on the other hand, we often find more numerous and more finished products, and wonderful adaptations, the origin of which is past our comprehension.* The naturalist in South America might well think species were created as he found them; the naturalist of the northern United States could hardly imagine such a thing, unless convinced on *a priori* grounds.

Yet when changes have occurred in tropical lands we find such phenomena as are common in the north. The snails of the Greater Antilles, islands that have undergone great changes of level in recent geological periods, are almost as confusing as the North American *Argynnis*. So, it seems, we may in some measure learn the

* For plants compare Dr. E. Warming's interesting paper in the *Botanical Gazette*, January, 1899.

past history of a group by studying its species. If the species are well defined and show elaborate adaptations to the environment the group has long existed under relatively uniform conditions. If, on the other hand, the species are defined with difficulty and connected by numerous races it may be presumed that the environment of the group has changed in recent times, and especially that it is undergoing expansion and differentiation in new territory. In northern regions the retreat of the ice has exposed much such territory; in the Antilles it has been the elevation of the land; in other cases a type may have found new lands by migration, and may thus exhibit incipient new species in the midst of a stable ancient fauna. As an example of the last-mentioned class may be mentioned *Danaüs berenice jamaicensis* in Jamaica, as against the old Jamaican type *Papilio homerus*. We have digressed from the immediate subject of this useful catalogue, but the interest of such works lies largely in the suggestiveness of their orderly and condensed array of facts.

T. D. A. COCKERELL.

MESILLA PARK, N. M., February 12, 1899.

Industrial Electricity. Translated and adapted from the French of HENRY DE GRAFFIGNY. Edited by A. G. ELLIOTT, B.Sc. London and New York, The Macmillan Company. Pp. 152. With 65 illustrations. Price, 75 cents.

This little volume, according to the editor's note, is the first of a series upon Electro-mechanics, the other volumes of which will treat the more important of the branches here touched upon, separately and in detail. It is divided into short chapters, and explains, in very clear and non-mathematical language, the various applications of electricity.

Beginning with Nature of Electricity, a *résumé* of Hertz's work is given, showing the identity of light and electrical vibrations. Then follow, in order, chapters on Electric Units, Magnetism and Induction, and Practical Measurement of Electrical Quantities.

Chapters V. and VI. are respectively on Chemical Generators of Electricity and Accumulators, covering the subjects of primary and storage batteries and containing much useful information and explicit directions as to handling and care.

Dynamo Electric Machinery is next touched upon, including direct current dynamos, alternators, two- and three-phase generators. The remaining five chapters merely touch upon the following subjects: Electric Light, Electricity as a Motive Power, Electro-chemistry and Electro-plating, Bells and Telephones, and Telegraphs.

The only criticisms that can be advanced are:

1. On page 12 the table gives 10°C.G.S. units in one Henry instead of 10⁹, while the table on page 27 has many of the dimensions of the mechanical, electro-magnetic and magnetic units given incorrectly.

2. Besides these lapses the volume is, with one or two exceptions, entirely devoid of allusions to American apparatus and machinery.

Taken as a whole, however, the volume is a creditable piece of work, for the task of condensing so much in so small a space is, to say the least, herculean.

W. H. F.

GENERAL.

THE Teachers' Professional Library, edited by Professor Nicholas Murray Butler, of Columbia University, is announced by The Macmillan Co. The books already published on 'The Development of the Child,' by Dr. Nathan Oppenheim; 'The Study of Children and their School Training,' by Dr. Francis Walker, and a 'Handbook of Nature Study,' by O. Lange, are included in the series and the following are announced for early publication:

'The Practical Lessons of History,' by William T. Harris, LL.D., U. S. Commissioner of Education.

'Social Phases of Education in the Home and in the School,' by Samuel T. Dutton, Superintendent of Schools, Brookline, Mass.

'Educational Aims and Educational Values,' by Dr. Paul H. Hanus, Harvard University.

'The Hygiene of the School and of Instruction,' by Edward R. Shaw, Ph.D., New York University.

'Method in Education,' by Walter L. Hervey, Ph.D., Department of Education, New York City.

'The Study and Teaching of History,' by Miss Lucy M. Salmon, Vassar College.

'The Study and Teaching of Geography,' by Dr. Jacques W. Redway, of New York.

'The Study and Teaching of English,' by Percival Chubb, of the Ethical Culture Schools, New York.

'The Study and Teaching of Mathematics,' by

David Eugene Smith, Ph.D., State Normal School, Brockport, N. Y.

It is announced that the government has compiled a History of the Territory of Alaska, bringing the explorations made by army officers up to date and including an elaborate description of the physical resources of the Territory. The compilation when published will make a large octavo volume of about 500 printed pages. The material was supplied, by the War Department under the direction of Assistant Secretary Meiklejohn, to the Senate.

BOOKS RECEIVED.

General Physiology. MAX VERWORN. Translated from the second German edition and edited by FREDERIC S. LEE. New York and London, The Macmillan Company. 1899. Pp. xvi + 615. \$4.00.

L'audition et ses organes. M. E. GELLÉ. Paris, Alcan. 1899. Pp. 326.

La Céramique ancienne et moderne. E. GUIGNET and EDOUARD GARNIER. Paris, Alcan. 1899. Pp. 311.

The Theory of the Leisure Class: an Economic Study in the Evolution of Institutions. THORSTEIN VEBLEN. New York and London, The Macmillan Company. 1898. Pp. vii + 400. \$2.00.

SCIENTIFIC JOURNALS AND ARTICLES.

THE American Mathematical Society is actively pushing the plans for the publication of its Transactions, and it is probable that the first number will appear in January next. A committee, consisting of Messrs. T. S. Fiske, R. S. Woodward, E. H. Moore, Maxime Bôcher and James Pierpont has been appointed to secure the necessary financial guarantees. Subscriptions of one hundred dollars annually for a term of five years have already been pledged by representatives and friends of each of the following institutions: Chicago University, Columbia University, Yale University and Bryn Mawr College. Other pledges are anticipated and the plan is already assured of success.

The Journal of Geology, Vol. 7, No. 1, for January and February, contains the following papers:

Frank Leverett: 'The Lower Rapids of the Mississippi River,' pp. 1-20. The writer discusses the abandonment by the Mississippi River of its pre-glacial channel just above Keokuk, Ia., and the production of the newer and

more contracted channel, in which are the rapids. The Kewatin ice sheet and its drift are regarded as the principal cause.

H. B. Kümmel: 'The Newark Rocks of New Jersey and New York,' pp. 23-53. The writer divides the strata under consideration into the Stockton, Lockatong, Brunswick and Trap formations. Their distribution, character, folding and faulting, and the conditions prevailing during their formation, are then discussed.

Henry S. Washington: 'The Petrographical Province of Essex County, Mass.,' II., pp. 53-64. The paper continues one that was begun in the last number. It describes, with analyses, the essexites, diorites, quartz-augite-diorites, porphyritic diorites and gabbros.

J. A. Udden: 'The Sweetland Creek Beds,' pp. 65-79. The beds are chiefly shale, and lie between the Cedar Valley Limestone below and the Coal Measures above, in Muscatine county, Ia. Fossils indicate an Upper Devonian Age.

G. H. Squier: 'Studies in the Driftless Region of Wisconsin,' pp. 79-83. One glaciated boulder has been found in a valley within the driftless region.

W. N. Logan: 'A Discussion and Correlation of certain Subdivisions of the Colorado Formation,' pp. 83-92. The paper discusses and correlates the subdivisions of this formation in the Kansas, Colorado, Black Hills and Iowa-Nebraska areas.

Editorials and reviews complete the number.

THE leading article in the *American Naturalist* for February, is by Dr. W. H. Dall, and discusses 'The Proposed University of the United States and its possible Relations to Scientific Bureaus of the Government.' Dr. Arthur Hollick continues the consideration of 'The Relation between Forestry and Geology in New Jersey,' this paper giving 'The Historical Development of the Flora,' concluding that the gradual extinction of the gymnosperm type is indicated. Professors J. H. Comstock and J. G. Needham also continue the subject of 'The Wings of Insects,' the chapter being devoted to the specialization of wings by addition as illustrated by the venation of the wings of Ephemera. Under the title of 'The Peneplain: a Review' Dr. R. A. Daly considers at length Professor Tarr's objections to the exist-

ence of peneplains on this earth of shifting base levels. Professor F. L. Washburn describes and figures the shoulder girdle of 'A Peculiar Toad,' presenting the abnormality of an extra (left) fore limb. The abundant literature on the subject of the Trenton Gravels receives an addition from Dr. Frank Russell, who describes some 'Human Remains from the Trenton Gravels,' concluding that the skulls which are figured are those of modern Indians, probably of the Lenni Lenapé. A goodly proportion of Notes and Reviews fill out the number.

THE *Journal of the Boston Society of Medical Sciences* for January comprises two parts, each containing a number of excellent plates. Those illustrating the articles on the 'Pathological Histology of Acute Lacunar Tonsillitis,' by J. L. Goodale, and the 'Character of the Cellular Exudation in Acute Keratitis of the Rabbit,' by W. T. Councilman, are particularly fine. Our anti-vivisection friends who discredit the existence of hydrophobia would do well to read the paper by Langdon Frothingham on 'Rabies in the Vicinity of Boston,' where 20 positive cases are noted between March, 1897, and December, 1898. An interesting series of 'Observations on the Effects Produced by the 6-mm. Rifle and Projectile,' by H. G. Beyer, is well calculated to create respect for the new Navy arm.

THE *Botanical Gazette* for February contains the following leading articles: 'New or Little Known North America Trees,' C. S. Sargent; 'The Ecological Relations of the Vegetation on the Sand Dunes of Lake Michigan,' Henry C. Cowles; 'The Society for Plant Morphology and Physiology—Columbia Meeting,' W. F. Ganong. The briefer articles include: 'Notes on the Maximum Thermal Death-point of *Sporotrichum Globuliferum*,' B. M. Duggar; 'Descriptions of Two Willows from Central America,' W. W. Rowlee; 'A Peculiar Case of Spore Distribution,' F. L. Stevens; 'A New Silphium,' Wm. M. Canby.

SOCIETIES AND ACADEMIES.

SECTION OF PSYCHOLOGY AND ANTHROPOLOGY OF THE NEW YORK ACADEMY OF SCIENCES.

At the regular monthly meeting of the section, on February 24th, papers were presented

by R. S. Woodworth on the 'Accuracy of Movement,' by F. C. Spencer on the 'Origin and Persistent Influence of Sacred Number Concepts,' and by F. Boas on 'Anthropometric Charts.'

Dr. Boas presented the results of recent investigations, which show that the anthropometric charts now used in the gymnasium by anthropologists are valueless as a means for estimating the development of individuals.

CHAS. B. BLISS,
Secretary.

ONONDAGA ACADEMY OF SCIENCE.

At the January meeting annual reports of officers and sections were received and the following officers were elected: President, John Van Duyn, M.D.; Vice-President, J. A. Dakin; Secretary, P. F. Schneider; Corresponding Secretary, H. W. Britcher; Treasurer, Miss L. W. Roberts; Librarian, Miss V. L. Jones.

The report of the Geological Section showed considerable progress in the investigation of interesting local problems, and cited the discovery of a vein of quartz crystals in the Corniferous rock at the Onondaga Indian Reservation.

The report of the Botanical Section included new localities for several of the rarer plants of the county. One plant, *Glaucium glaucium*, was reported as new to the county, and two, *Crepis virens* and *Sanguisorba canadensis*, were reported as new to the State. *Selaginella selaginoides* was also found and is probably new to the State.

The report of the Zoological Section contained the result of feeding experiments on the larvæ of *Diedamia inscripta*. During the year upwards of thirty spiders were added to the list of Onondaga county species. Of these, nine species had not hitherto been reported in the State.

H. W. BRITCHER.

DISCUSSION AND CORRESPONDENCE.

WHAT IS THE CAUSE OF THE SO-CALLED TOBACCO FERMENTATION?

THUS far it has been generally believed that the rise of temperature and the chemical changes that take place when the cured tobacco leaves are piled up in heaps are due to bacterial action. But careful investigations of the 'fer-

menting' leaves revealed the absence of extended bacterial colonies, the presence of which were naturally to be expected if *bacteria* were the cause of the phenomena in question. The true cause, I have recently established beyond a doubt, is the presence of two kinds of *oxidizing enzymes* in the tobacco leaves. As soon as the Bulletin describing these investigations is published a full review will be given in this JOURNAL.

OSCAR LOEW.

DIVISION OF VEGETABLE PHYSIOLOGY AND PATHOLOGY, U. S. DEPT. OF AGRICULTURE.

THE ANÆSTHETIC EFFECTS OF A SINUSOIDAL CURRENT OF HIGH FREQUENCY.

TO THE EDITOR OF SCIENCE: In your issue of June 3, 1898, I had the honor of communicating an observation on the anæsthetic effects of a sinusoidal current of high frequency. I take the liberty of sending you the following further observations.

a. The anæsthetic effect may be produced by sending the current longitudinally along the nerve. Thus, a current sent along one of the nerves of the arm can be used to produce anæsthesia in parts of the arm supplied by it. With a pleasant current of about 28,000 alternations per second passing between the elbow and the hand, a needle can be painlessly run into the forearm.

b. At the suggestion of Professor B. Moore, of the Yale Medical School, I applied the current to the tongue, with a view to testing the theory that the sensation of taste may be due to vibratory stimuli. If the theory were true the fluctuations in the sinusoidal current might be expected to produce sensations of taste of various kinds. The experiment showed that fluctuations up to about 29,000 complete periods per second produce no sensations of taste whatever; the only sensation is that of tickling and puckering.

c. It should perhaps have been stated in my original communication that the main purpose of the investigations with the sinusoidal current was to determine the various sensations at different frequencies. They have been determined for two subjects as follows: (1) Threshold of sensation of touch at a frequency of about

480 complete alternations per second; (2) threshold of disagreeableness at about 840; (3) threshold of pain at about 960; (4) disappearance of pain at about 1,440, followed by a peculiar, agreeable sensation; (5) disappearance of agreeableness at a point not yet determined, followed by a faint sensation; (6) disappearance of sensation at a point not yet determined. For constant conditions these figures are quite constant, the probable error ranging from $\frac{1}{16}$ of 1 % to 4 %.

d. Applying the electrodes to the nerves of the arm in a way to move the muscles of the forearm and hand I find a similar neuromuscular effect. As the current rises in frequency from zero the muscles contract steadily up to a certain point, after which they gradually relax. The process is the same when we start with a high frequency and descend to zero. The phenomenon can hardly be due to a diminished intensity of the high-frequency current.

e. It may be added that the instrument used is a Kennelly alternator run at a very high speed. Similar high-frequency machines have been used by Nikola Tesla, who has not recorded any of the above phenomena; possibly his machines do not produce sinusoidal currents.

f. Using another machine which simply interrupted a galvanic current up to 100,000 times per second I find that above a certain point (not yet measured) the interruptions cease to have any effect other than merely reducing the strength of the current when it is sent through the tissues.

E. W. SCRIPTURE.

YALE UNIVERSITY, NEW HAVEN, CONN.,

February 28, 1899.

NOTES ON PHYSICS.

THE METRIC SYSTEM.

THE Hartford Steam Boiler, Inspection and Insurance Company of Hartford, Conn., has issued a very neat and convenient volume, of 'pocket size,' containing tables for the Conversion of English weights and measures into their metric equivalents, and *vice versa*. It opens with a very interesting discussion of the metric system, which lacks, however, any recognition of the International Bureau of Weights and

Measures and the great work it has accomplished during the past twenty-five years. Nothing is said about the International Prototype units of length and mass, which are the real standards of the world to-day, and it is implied that the meter and kilogramme are, except for practical purposes, what they were defined to be a hundred years ago. The ratios of the metric to our customary units used, in the book, are not those legally adopted by the U. S. Office of Weights and Measures, but the differences are so small that the conversion tables are not sensibly in error. There is a growing use of the metric system in this country, the result of an increasing trade with foreign countries, and this book will satisfy every demand of those who are called upon to convert from one system to the other. The tables are so numerous that it is difficult to imagine a call for anything which the book does not contain, and a convenient index renders them quickly available. Much time is saved by carrying the tables up to one-hundred multiples of each unit, but in a few instances space and labor have been wasted in doing this, because of the impossibility of such conditions ever being realized. For instance, in the table for converting 'grammes in a cubic centimeter to ounces in a cubic inch,' there does not appear to be any necessity for going beyond 23 or 24—as there is no known substance denser than this. Thus more than three-quarters of this table can be of no use, and this is true of several tables of a similar character. On the whole the work is exceedingly well done, and the book ought to be much sought after.

T. C. M.

THE ELECTROLYTIC INTERRUPTER FOR THE INDUCTION COIL.

WHEN a high electro-motive force is connected to an electrolytic cell, one electrode of which is very small, the rush of current which takes place is quickly interrupted by the layer of gas which is generated at the small electrode. This layer of gas then collects as a bubble, the electrolyte again comes into contact with the electrode, a rush of current again takes place to be interrupted as before, and so on. These interruptions are very abrupt, and their frequency varies from two or three hundred to a thousand or more per second according to the size of the

small electrode and the inductance of the circuit. The small electrode should be the anode.

Dr. A. Wehnelt (*Electrical Engineer*, February 16, 1899) has applied this electrolytic interrupter to the induction coil. He uses dilute sulphuric acid, a sheet of lead as cathode, and the tip of a small platinum wire projecting from a glass tube as anode. The interrupter works with entire satisfaction with electro-motive forces as high as 110 volts; the condenser, needed with the ordinary interrupter, is useless; and the effectiveness, especially of small coils, is greatly increased both in length of spark and frequency.

Dr. Wehnelt's experiments have been repeated in the Physical Laboratory at Bethlehem Pa., his results have been confirmed, and it has been found that the primary of an induction coil should be wound with more turns of wire than usual to give the best results with this electrolytic interrupter. The interrupter gives good effects when used to supply intermittent current to the primary of a small transformer. Thus a small step-down transformer taking 375 watts from the mains gave out about 30 watts from its secondary.

When the electrolytic interrupter is used to supply intermittent current from a 110 volt source to the primary of a transformer, the e. m. f. which establishes the current after each break is, of course, 110 volts, while the e. m. f. which stops the current is the e. m. f. between the break points and may be very greatly in excess of 110 volts.

The effective primary e. m. f. is, therefore, on the whole, greatly in excess of 110 volts, so that a 1:1 transformer may give several hundreds of volts at its secondary terminals when supplied with intermittent current from a 110 volt source.

This is shown by the fact that a 220 volt lamp, for example, may be lighted from the secondary, and, of course, it may be lighted equally well or even better if connected across the primary terminals.

W. S. F.

THE RESISTANCE OF CARBON AND COPPER BRUSHES.

PROFESSOR E. ARNOLD gives, in the *Electrical Zeitschrift* for January 5th, a study of the 'Con-

tact Resistance of Carbon and Copper Brushes and the Temperature Rise of the Commutator.' He finds that the contact resistance decreases with increase of current density, especially with higher velocities of commutator surface; thus, with a velocity of 868 meters (1205 ft.) per minute, the resistance per sq. cm. is for .7 amp. per sq. cm. .6 ohm., while for 10 amp. it becomes only .1 ohm., beyond which point it is nearly constant. He finds also that for a given current density the resistance increases with speed to a maximum, and then decreases for higher speeds; this he accounts for by supposing an unfavorable relation between the weight of the brush and the periodicity of the vibrations from passing over the segments; this theory is upheld by the fact that the same maximum appears at a lower speed for the heavier copper brush. A highly polished metal surface gives a higher resistance, which oiling increases still further. He mentions eddy currents as producing losses in the segments, and gives formulæ for the friction losses and the rise of the temperature.

F. C. C.

ENZYMES AS REMEDIES IN INFECTIOUS DISEASES.

DURING the past year Drs. R. Emmerich and Oscar Loew have been engaged upon an interesting problem in connection with enzymes as remedies in infectious diseases. The work was carried on in Munich, and as yet the results have not been published in full. We are indebted to Dr. Loew for the following facts in regard to the investigations: It has been surmised by Nencki and by Pfeiffer that the substances leading to recovery from infectious diseases, and producing immunity from them, belong to the enzymes. The latter author believed that these enzymes are prepared by the animal organs and not by bacteria themselves. Dr. de Schweinitz has observed an enzyme in cultures of the hog cholera germ which had a potent action in rendering guinea pigs insusceptible to this disease. However, this enzyme exhibited poisonous action in but little higher doses than necessary for immunizing.

Recently Emmerich and Loew have proved that certain kinds of bacteria, for example,

Bacillus pyocyaneus, produce enzymes which not only dissolve these bacilli themselves, but also other microbes, such as the germs of cholera, typhoid fever, anthrax, diphtheria, black plague, staphylococci and probably also gonococci. The germs of tuberculosis and many others are not affected by this enzyme within 24 hours. *Micrococcus prodigiosus* can also produce a bacteriolytic enzyme, which does not appear to act so favorably as that of the *Pyocyaneus*. The *Micrococcus erysipelatos* produces one, but this is associated, as in many other cases, with very poisonous qualities.* Emmerich and Loew have demonstrated that in a rabbit first infected with anthrax and then treated with subcutaneous injections of the concentrated enzyme of the *Bacillus pyocyaneus* the anthrax bacilli in the spleen are found completely broken up and partly dissolved, exactly as it can be observed *in vitro* when a dose of millions of anthrax and the other named bacilli are transferred into a few cubic centimeters of the concentrated and purified pyocyaneus enzyme. The latter enzyme can, by combination with an animal protein, be transformed into an immunizing substance. The authors have succeeded in obtaining both these agencies in a durable solid form. Thus the time seems near at hand when the treatment with serum will be replaced by a cheaper and simpler method, at least in certain cases.

B. T. GALLOWAY.

SCIENTIFIC NOTES AND NEWS.

THE refusal of Congress to establish a permanent census bureau for the proper conduct of the work has had its natural sequence in the appointment of a politician as Director of the Twelfth Census. The best that can be said of ex-Governor Merriam is that he had a creditable record as Governor of Minnesota. The New York *Evening Post* speaks of the appointment as follows: "Mr. Merriam is appointed Director of the Census simply because there was no other good office vacant at home or abroad. He has never had any experience as

*The bacillus of the black plague, that of tuberculosis, and other kinds, seem incapable of producing bacteriolytic enzymes, at least not to any noticeable degree, and the serum of black plague has, therefore, been applied without success in the cases at Vienna.

a statistician, and possesses none of those expert qualifications which the place imperatively demands. He is a spoilsman, and can be trusted to run the bureau on a spoils basis, from top to bottom. No appointment could be made which would so certainly secure the failure of the next census as a trustworthy and creditable work."

MR. F. H. WINES, who has been appointed Assistant Director of the Census, is an expert statistician.

THE nomination of Mr. Barrows as Librarian of Congress has failed of confirmation by the Senate. It is to be hoped that the action of the Senate was due to the fact that Mr. Barrows is not a librarian by profession, and not to the fact that he is a good executive officer, who would probably have administered the National Library without regard to party considerations.

THE civilian members of the United States Philippine Commission, President Schurman, of Cornell University; Col. Charles Denby, and Professor Dean C. Worcester, of the University of Michigan, have arrived at Manila.

D. ANTON FRITSCH, Director of the Natural History Museum of Prag, who has just begun publishing the fourth volume of his *Fauna der Gaskohle* of the Permian of Bohemia, sails for New York in the *Kaiser Wilhelm* on March 28th, to visit the museums of this country.

PROFESSOR T. E. THORPE, F.R.S., has been nominated for the presidency of the Chemical Society, London, and Mr. William Whitaker, F.R.S., has been elected President of the Geological Society, London.

WE regret to learn that Dr. J. J. Valentini, the student of Mexicana, is seriously ill with pneumonia at St. Luke's Hospital, New York City.

DR. H. FOSTER BAIN, Assistant State Geologist of Iowa, is delivering a course of lectures on economic geology to the graduate students in geology at the University of Chicago. Dr. W. S. Beyer, professor of geology and mining in the Iowa State College of Agriculture and Mechanic Arts, has charge of the office of the Iowa Geological Survey at Des Moines during Dr. Bain's absence.

MR. M. A. CARLETON, who has been engaged

for several years upon an investigation of the rusts affecting cereals, has just returned from Russia, where he has been collecting cereals for use in this country in connection with the investigations now being carried on by the Section of Seed and Plant Distribution. Mr. Carleton has collected much valuable material and information which will further the work of the Division of Vegetable Physiology and Pathology on cereal diseases and the breeding of new and valuable varieties.

ARRANGEMENTS have been made by the Rothschilds to send Mr. G. W. Dunn on an expedition to the Philippine Islands for the collection of objects of natural history. Mr. Dunn has made many collecting expeditions to South America and Mexico. He is at present 85 years of age.

SIGNOR MARCONI described and demonstrated his method of wireless telegraphy at a meeting of the British Society of Electrical Engineers on March 2d.

THE Academy of Sciences of Vienna has made a new departure in entertaining at a banquet Dr. Gerhardt Hauptmann, the eminent dramatic writer. Dr. Ed. Suess, the President, presided and made an address in honor of Dr. Hauptmann.

ON the retirement of Mr. W. H. Preece, C.B., the British Postmaster-General has appointed Mr. J. Hookey, previously assistant engineer-in-chief, to be engineer-in-chief of the post office, and he has also appointed Mr. J. Gavey to be assistant engineer-in-chief and electrician.

M. BOUQUET DE LA GRYE has been appointed President of the Council of the French Bureau of Meteorology. M. Darboux has been appointed Vice-President and M. Anthoine, Secretary.

DR. ALLAN McLANE HAMILTON, professor of mental diseases in Cornell Medical College, has been elected a member of the Royal Society of Edinburgh.

A CIVIL SERVICE examination will be held on April 11-12, 1899, for the position of Assistant in Irrigation, Office of Experiment Stations, Department of Agriculture, at a salary of \$1,500 per annum. The examination will consist of

the subjects mentioned below, which will be rated as follows :

<i>Subjects.</i>	<i>Weights.</i>
1. Drafting,	30
2. Theory and practice of irrigation,	20
3. Irrigation engineering,	20
4. Essays on irrigation subject,	20
5. Training and experience,	10
Total,	100

WE learn from *Nature* that at the annual meeting of the Russian Geographical Society, on February 2d, the following medals were awarded : The Constantine medal to Dr. Gustav Radde, the director of the Tiflis Museum, for his forty-five years' work in the study of Russia ; the Count Lütke medal to I. I. Pomerantseff, for his researches into the forms of the earth's geoid in the province of Fergana ; the Semonoff medal to M. Kleiber, for his investigations into the periods of high water in the Volga ; the great gold medal of the Section of Ethnography to N. L. Gondatti, for his three years' work of exploration of the Land of the Chuckchis ; the Przewalski medal to L. A. Jaczewski, for his physico-geographical researches in Siberia ; and three small gold medals to M. Tachaloff, for his instruction of travellers in astronomical observations ; A. A. Rostkovsky, for a map of population in the Bitol vilayet of Turkey ; and N. A. Zarudnyi, for researches in Persia ; a number of silver medals were awarded for minor works.

It is proposed to establish, with the sum of \$5,000, at the University of Glasgow, a prize in pathology in memory of the late Professor Joseph Coats.

STEPS are being taken to found a memorial in honor of the late Robert Hebert Quick, who accomplished much for the advancement of education in Great Britain. It is hoped that £500 may be collected and used to endow a Quick Memorial Library at the Teachers' Guild, London, where Mr. Quick's educational library is at present deposited. Subscriptions may be sent Mr. John Russell, Cripplegate, Woking Surrey.

ARRANGEMENTS are being made to collect a fund in memory of the late Professor Kanthack. Owing to his early death, Mrs. Kanthack is not sufficiently provided for, and it is proposed that

the income of the fund be given to her and at her death be used for a permanent memorial to commemorate his important contributions to pathology. Subscriptions may be sent to Dr. J. H. Drysdale, 25 Welbeck-street, London, West.

MAJOR GENERAL JOSEPH J. REYNOLDS, U. S. A., formerly professor of mechanics and engineering at Washington University, St. Louis, and during and since the Civil War a distinguished officer of the army, died on February 26th, at the age of 77 years.

THE death is announced of Alexandre Laboulbene, professor of the history of medicine in the University of Paris, at the age of 73 years. Dr. Laboulbene had not only published valuable works on the history of medicine, but was also well known as a pathologist and entomologist, having published a '*Traité d'Anatomie Pathologique*' and a '*Faune Entomologique Française*.'

WE regret also to record the death of Dr. William Rutherford, professor of physiology in the University of Edinburgh, which occurred on February 21st, from a relapse following influenza. We learn from the *London Times* that Professor Rutherford was born at Ancrum Craig, Roxburgshire, in 1839, and was educated first at Jedburgh Grammar School, and afterwards at Edinburgh University, where he graduated with honors in 1863, obtaining a gold medal for his thesis. He held office as house physician and house surgeon in the Edinburgh Royal Infirmary under Dr. Rutherford Haldane and Professor Spence, and then taught anatomy for a year in the Surgeons' hall under Dr. Struthers. He afterwards went to the Continent and studied at the great medical schools of Berlin, Vienna and Paris. In 1865 he was appointed University assistant to the late Professor John Hughes Bennett. In 1869, when only 30 years of age, he was appointed professor of physiology in King's College, London, a post which he filled for five years, during three of which he was also Fullerian professor of physiology in the Royal Institution, London. His reputation as a teacher and lecturer spread rapidly, and in 1874, on the resignation of Professor Hughes Bennett, he was appointed to the chair of physiology in Edinburgh University.

Here he labored till the close of his life, and did much to develop the practical teaching of physiology, both in lectures and by the institution of practical classes. His chief work was 'The Action of Drugs on the Secretion of Bile,' and he was also the author of 'Outlines of Practical Histology,' and a 'Text-book on Physiology,' besides many papers on various scientific subjects. His recent efforts were chiefly directed to the study of hearing, sight and other special senses. He was also the inventor of the freezing microtome, which has proved of great value in microscopical research and demonstration. In 1876 Professor Rutherford was elected a Fellow of the Royal Society of London.

THE French Mathematical Society is making active arrangements for the International Congress of Mathematicians, to be held at Paris, from the 6th to the 12th of August, 1900. Replies have already been received from 900 intending members. A meeting was recently held at Göttingen, at which representatives of the Academies of Vienna, Munich and Leipzig were present for the purpose of planning a program for the Congress.

A COMMITTEE, of which Professor Newcomb is the chairman, is collecting information in regard to the best methods for observing the total eclipse of the sun on May 28, 1900. The track of the shadow runs from New Orleans to Norfolk and across to Spain and Algeria. Arrangements are also being made by the British Astronomical Society. A paper was read by Mr. A. C. D. Krommelin before the Society on February 22d. As a result of a close study of the weather statistics the conclusions he drew were: (1) That Algiers was certainly worth occupying on account of its low cloud ratio, its accessibility and its excellent harbor; (2) that the Portuguese stations had a higher cloud ratio, but a longer totality (1 min. 36 sec., as compared with 1 min. 6 sec. at Algiers); (3) the region south of Madrid had a low cloud ratio, and several railway lines cut the shadow track, so that there would be no difficulty in transporting instruments; (4) the Alicante region seemed less clear than central Spain, but more so than Portugal. The Association's special steamer could land detachments at various

points on the Portuguese and Spanish coasts, and then proceed to Algiers with the remainder of the party. It could remain at Algiers as a floating hotel to the party, and after the eclipse return by the same route, picking up the various detachments.

American Gardening, New York City, offers prizes amounting to \$150 for papers on hybridization treated from the point of view of its relations to science and horticulture. The papers must be between 1,000 and 5,000 words in length and must be sent in before April 15th.

THE Paris Academy of Sciences has received a legacy of 35,000 fr. from M. Paul Frédéric Hély d'Oissel.

THE late Dr. E. F. A. Obach has bequeathed his scientific library to the Siemens' Engineering Society, Woolwich, with the exception of his special library on india rubber, which, with specimens, etc., is left to the Botanical Museum, Berlin.

THE Zoological Society of London has subscribed £200 towards the fund being collected for a British Antarctic expedition.

THE Goldsmith's Company, London, has made a further grant, this time of £500, for the continuation of experiments on the anti-toxin treatment of diphtheria undertaken under the direction of the Royal Colleges of Physicians and Surgeons.

A HUNDRED-YEAR Club has been established in New York City, and will be glad to receive members whose only duties are to pay the annual fees and to try to pledge themselves to endeavor to live and persuade others to live more than a hundred years. A beginning has been made by a dinner at the Waldorf-Astoria.

IN connection with the work on pear blight conducted by Mr. M. B. Waite, of the Division of Vegetable Physiology and Pathology, United States Department of Agriculture, an interesting feature has been developed in the way of growing the bacillus of blight on dormant pear shoots. The fact that the organism could be grown in this way was discovered by Mr. Waite about two years ago, and it furnishes means of throwing light on a number of points connected

with the disease. For illustrative purposes in class rooms or elsewhere it forms one of the most striking examples of the effects produced by a bacterial plant disease. Shoots the size of a lead pencil or a little larger are cut from pear trees, and after being washed in a clean water their upper ends are cut in a slanting way with a sharp sterilized knife. The shoots are then placed in a glass containing water, with the slanting ends free. The glass and its contents are now set in a plate or dish containing water, and a bell jar or large beaker placed over them in such a way that the rim is immersed in the water in the plate. This insures a saturated atmosphere and other conditions unfavorable to the shoots, but favorable to the germs themselves. Infections with pure cultures of the blight bacillus on the slanting cut surfaces of the shoots begin to show as beautiful, pearly-white, bead-like colonies in from 36 to 48 hours, and as the disease progresses, which it does more or less rapidly under varying conditions of heat, the changes in the host and parasite may be easily watched.

THE new *Turbinia*, of 220 feet in length and 330 tons displacement, is, as we learn from the *London Times*, in an advanced state of construction at Ellswick, and hopes are being entertained of her being tried in two months from the present time. The modifications found to be desirable after the exhaustive trials of her predecessor are considerable. The new vessel has eight propellers on four shafts, instead of the original *Turbinia's* three shafts and nine propellers. Her 'going-astern' arrangements are far in advance of those of the pioneer boat, whose extreme speed caused great excitement in the Solent at the time of the Naval Review of 1897.

UNIVERSITY AND EDUCATIONAL NEWS.

PRESIDENT TAYLOR, of Vassar College, has declined the call to the presidency of Brown University.

MR. A. E. H. LOVE, F.R.S., Fellow of St. John's College, Cambridge, and University lecturer in mathematics, has been appointed Sedleian professor of natural philosophy in succession to the late Professor Bartholomew Price.

MR. A. W. HILL has been appointed demonstrator in botany in Cambridge University.

ROLLINS A. EMERSON, of Washington, D. C. who was elected to the chair of horticulture in the University of Nebraska in June, 1898, assumed the duties of the position March 1st. After resigning his position in the Division of Experiment Stations in the Department of Agriculture, he spent some time in study in Cornell University before taking up his new duties.

DR. H. E. ANNETT has been appointed demonstrator of tropical pathology in the newly-founded school of tropical diseases in Liverpool. Both Edinburgh and Aberdeen have taken steps to establish lectureships on the diseases of tropical climates.

THE chair of natural history at Aberdeen, vacant by the death of Professor Nicholson, will, it is expected, be divided, and professorships of geology and zoology will be established.

THE late Mrs. Martha S. Pomeroy has bequeathed to Wellesley College \$60,000 for the erection of a dormitory, and also the residue of her estate.

WE are also glad to record the following gifts and bequests: Miss Maria Hopper has given \$10,000 to Bryn Mawr College for the foundation of a scholarship. Syracuse University has received \$5,000 from the heirs of H. H. Crary, of Binghamton, in accordance with the wishes he had expressed. The University of North Carolina has been given \$15,000 by Mr. Julian S. Carr. Swarthmore College has received \$5,000 by the will of the late Daniel Underhill.

THE late Professor Rutherford has bequeathed to Edinburgh University his valuable medical library and his collection of physiological and microscopical specimens.

ON the fifteenth of February the University of Nebraska celebrated its thirtieth anniversary. It has been the custom for many years to observe 'Charter Day' as a holiday, and to have parades, military exercises, addresses, etc., and for several years degrees have been conferred upon such students as completed their work at this time. On the present occasion seven students received the bachelor's degree and two

the master's degree. The University address was given by Dr. A. F. Nightingale, Superintendent of High Schools, Chicago. During the evening exercises Governor Poynter made the welcome announcement that he had that morning signed the 'University Revenue Bill' and that it was now the law of the State. This bill is one in which all the friends of the University were much interested. It provides first for the classification and handling of the funds of the University, as follows: The permanent endowment fund, the temporary University fund, the University cash fund, the United States Morrill fund and the agricultural experiment station fund, and requires that the State Treasurer shall be the custodian of all University funds. The second and by far the most important provision is that by which the University tax is increased from three-eighths of a mill to one mill on each dollar of valuation of the 'grand assessment roll' of the State. This will place a much larger sum in the hands of the Regents of the University and will enable them to plan for larger things in the future. It is one of the most important acts of any Legislature in Nebraska in its bearing upon higher education.

We hope that the following item printed in the *San Francisco Call* is correct: "Three measures for the benefit of Stanford University have been presented in the California Senate. They are in the form of amendments to the political code, allowing corporations formed for educational purposes to accept gifts and bequests. When the bills finally become laws Mrs. Stanford stands ready to turn over her own personal fortune of more than \$5,000,000 to the college, and Governor Stanford's brother, who has made a fortune in Australia, will turn over in installments nearly \$15,000,000 more. This vast sum, with the present funds at the disposal of the college, will place it on a financial standing far beyond its competitors. Under the present provisions of the codes an educational institution cannot accept a gift or bequest. It was the intent of the law to prevent certain eleemosynary institutions from securing possession of large tracts of land and sums of money, and hold them, with no benefit to anyone, and so when it was desired

to endow the University with all the Stanford millions it was found to be impossible to do so under the laws of the State. It was about year ago that the Australian Stanford first broached the subject of adding his millions to those of his brother. It had always been Governor Stanford's wish that his childless and kinless brother should follow his example regarding the University, and a year ago it was decided to bring the two fortunes together."

THE annual report of President Eliot, of Harvard University for 1897, is, as usual, an educational document of great importance. With the appended reports of the deans of the faculties and schools and the directors of the scientific establishments it contains 322 pages, and the report of the Treasurer is given in much detail, occupying 89 pages. Among the subjects considered is President Eliot's favorite plan of reducing the College course to three years, it being pointed out that more than one-third of the students do practically complete the work required in this time. It is noted that men of high scholarship are fully equal to others in physical development, as shown by the gymnasium records. President Eliot finds that during the past twenty-seven years the number of members of the faculty has increased more rapidly than the number of students and that the average ages of the members of the faculty has decreased by less than one year. The instructors of the first three classes are considerably older than formerly, while the instructors of the senior class are younger. The average age of the Harvard instructor is about forty years. During the year the requirements for admission to Harvard College and the Lawrence Scientific School were revised in a manner favorable to the sciences. The text-book study of physics and astronomy is omitted and four new subjects are offered, namely, astronomy, physiology, meteorology and anatomy, with physiology and hygiene. No reason is given for not allowing zoology or botany to be elected, yet these are perhaps the sciences which can be best taught in the ordinary preparatory schools. The terms of admission to the Lawrence Scientific School will, we are glad to learn, gradually be raised to substantial equality with those of the College.



FIG. 1. Belt plate, etc.



FIG. 4. Adjustment for transverse space waves.



FIG. 2. Cam axes with one, two and three wave-lengths.

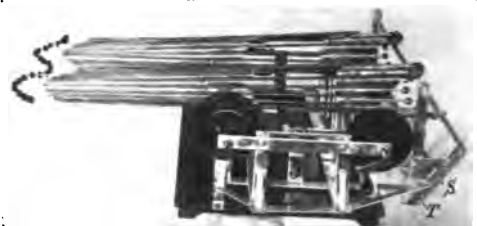


FIG. 5. Adjustment for compounding circular and plane polarized waves.



FIG. 3. Adjustment for plane polarized waves.



FIG. 6. Adjustment for rotary polarization.

SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; J. LE CONTE, Geology; W. M. DAVIS, Physiography; O. C. MARSH, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; HENRY F. OSBORN, General Biology; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; J. McKEEN CATTELL, Psychology; DANIEL G. BRINTON, J. W. POWELL, Anthropology.

FRIDAY, MARCH 17, 1899.

CONTENTS:

<i>The Objective Presentation of Harmonic Motion</i> (with Plate II.): PROFESSOR CARL BARUS.....	385
<i>The Work of the U. S. Fish Commission</i>	406
<i>Engineering and the Professions in Education</i> : PROFESSOR R. H. THURSTON.....	407
Scientific Books:—	
<i>Loew's Die Chemischen Energie der lebenden Zellen</i> : DR. ALBERT F. WOODS. <i>Davis's Physical Geography</i> : PROFESSOR ALBERT PERRY BRIGHAM. <i>General Books Received</i>	409
Societies and Academies:—	
<i>The Geological Club of the University of Minnesota</i> : DR. F. W. SARDESON. <i>The Botanical Club of the University of Chicago</i> . <i>Entomological Society of Washington</i> : DR. L. O. HOWARD. <i>The Academy of Science of St. Louis</i> : PROFESSOR WILLIAM TRELEASE.....	412
Discussion and Correspondence:—	
<i>The Importance of Establishing Specific Place-Modes</i> : PROFESSOR CHAS. B. DAVENPORT. <i>Identity of Common and Labrador White-Fish</i> : DR. TARLETON H. BEAN. <i>A Date-Palm Scale Insect</i> : PROFESSOR T. D. A. COCKERELL. <i>The Choice of Elements</i> : T. D.....	415
Astronomical Notes:—	
<i>Tuttle's Comet</i> ; <i>A New Star in Sagittarius</i> : PROFESSOR E. C. PICKERING.....	417
Notes on Physics:—	
<i>Electric Wire Waves</i> ; <i>A New Indicator for Electric Waves</i> ; <i>The Electric Discharge in Rarefied Gas</i> ; <i>Brilliance of Light Sources</i> : W. S. F. <i>The Magnetization of Iron</i> ; <i>General</i> : A. ST. C. D....	418
<i>Scientific Notes and News</i>	420
<i>University and Educational News</i>	424

MSB. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

THE OBJECTIVE PRESENTATION OF HARMONIC MOTION.

CONTENTS.

DESCRIPTION OF A WAVE MACHINE.

1. Introductory.
 2. General construction.
 3. Cam axles.
 4. Levers, riders and balls.
- Action of the machine.
5. Method of compounding.
 6. Plane transverse waves.
 7. Transverse space waves.
 8. Compressional space waves.
 9. Rotary polarization.

EXPERIMENTS.

10. Method of designating phases. Plane waves.
 11. Do. Space waves.
 12. Effective circles of reference.
- I. Compound S. H. M's coplanar of the same wave-length.
13. Plane polarization curves.
 14. Waves of constant amplitude.
 15. Waves of varying amplitude.
- II. Preceding case (I) with additional velocity superimposed on either wave-plane.
16. Beats.
 17. Döpler's principle.
- III. Preceding cases (I and II) with the velocity of either wave-train reversed.
18. Equal velocities. Stationary waves. Reflection.
 19. Wandering nodes.
- IV. Component S. H. M's at right angles to each other, of the same amplitude and wave-length.
20. Elliptic polarization.
- V. Preceding case (IV) with component velocities and periods unequal.
21. Incommensurable periods.
- VI. Preceding case (IV) with either component velocity reversed.

- 22. Velocities equal.
- 23. Velocities unequal
- VII. Preceding case (IV) adjusted for rotary polarization.
- 24. Plane and helical compounds.
- VIII. Waves of compression and rarefaction.
- 25. Longitudinal vibration.
- 26. Reflection.
- IX. Component S. H. M's. coplanar, with wave-length ratio, 1:2.
- 27. Harmonic curves.
- 28. Waves.
- 29. Case IX with component velocities unequal.
- 30. Case IX with one component velocity reversed.
- X. Component S. H. M's. at right angles to each other, with wave-length ratio 1:2.
- 31. Harmonic curves.
- 32. Waves.
- 33. Case X with component velocities unequal.
- XI. Components S. H. M's. coplanar with wave-length ratio 2:3.
- 34. Plane harmonics and waves.
- XII. Component S. H. M's. at right angles to each other with wave-length ratio, 2:3.
- 35. Transverse space waves.
- XIII. Component harmonics circular and vertically simple harmonic of any wave-length ratio.
- 36. Harmonic curves for equal component wave-lengths.
- 37. Waves.
- 38. Curves and waves for other component wave-lengths.
- XIV. Component harmonics both circular, of any wave-length ratio, and opposite in direction.
- 39. Remarks on the machine.
- 40. Rotary polarization. Equal component wave-lengths
- 41. Do. Unequal periods and velocities.
- 42. Unequal component wave-lengths. Equal velocities.
- 43. Do. Unequal velocities.
- 44. Right-handed circular component harmonics.
- 45. Do. Unequal velocities. Equal wave-lengths.
- 46. Do. Unequal wave-lengths.

DESCRIPTION OF A WAVE MACHINE.*

1. *Introductory.* — Although wave machines of a variety of special patterns are well known, none of them, to my knowledge, are sufficiently comprehensive in design to embody in a single mechanism the types of

* Compiled from notes on lectures delivered at Brown University.

harmonic motion met with in acoustics, light, electricity and elsewhere, with a clear bearing on their kinematic analysis. I will, therefore, venture to describe such a machine, even at the risk of becoming prolix, believing the apparatus to be more complete than any similar machine which I have seen, and having, after considerable experience, become assured of its usefulness in class work.

The machine which I have in view must be able, in the first place, to compound any two simple harmonic curves for any difference of amplitude period and phase. The compound harmonic of two, or, at the most, three, components is quite complex enough for illustration, and whatever advantage may be gained from further components is more than counterbalanced by additional complexity of apparatus. The wave machine must next be able to set all the compound harmonics in vigorous motion,* thus producing what I should like to call a train of resolute complex waves (not decrepit waves or waves of deficient vitality); it must do this when the components (meeting at the origin initially in any difference of amplitude period or phase) travel with the same or with different velocities in the same direction or in opposite directions. The latter adjustment affords an admirable illustration of the phenomenon of stationary waves, either with fixed or with wandering nodes; the other an equally apt illustration of musical beats for slight differences of periods or slight differences of wave velocity. Döpler's principle is thus put in evidence. Relative to stationary waves the adjustment is to be set either for reflection with or without change of phase in such a way as to clear up the wretched confusion which usually surrounds this subject in elementary physics.

With these possibilities for plane polar-

* In this respect the photographs fail utterly to suggest the beauty of the machine when in action.

ized waves, the apparatus must next fully represent the corresponding cases for transverse waves in space. It must, therefore, represent all cases of elliptic and of higher (one might say Lissajous) polarization, both as regards the compounding of harmonic curves for all differences of amplitude period and phase of the two components and the corresponding waves resulting for like or different velocities of the components in the same or in opposite directions. It must show that the section of such waves are Lissajous curves for the particular ratio selected, and that these curves are either fixed or in uniform variation as the component wave-lengths, velocities and periods correspond or not.

The machine should, furthermore, be able to compound simple harmonic and circular motion, showing both the complex harmonics and the waves, to which all variety can be given by changes of amplitude, period and phase. Indeed, types of singular complexity are thus obtainable.

Again, the machine should compound two opposite uniform circular motions, differing in period or wave velocity or both, showing the helical harmonic curves as well as the twisted vibratory waves, with special reference to rotary polarization.

Finally, compressional waves must be obtainable, and this with particular reference to their inherently simple harmonic character.

The machine itself must be made not only of easily replaceable parts and sufficiently simple to resist wear and tear, but so fashioned that the functions of the active appurtenances may be understood from mere inspection. As I have carried it out, the machine is built almost entirely of stout tin plate (about .027" thick) folded to secure rigidity, with axles of brass tube to facilitate soldering. Anybody in possession of an ordinary roofman's tin bender* for making

lap joints, and a little skill in soldering, can make the machine for himself at a trifling cost.

2. *General Construction.*—Fig. 1 shows the bed plate of the machine with the attached permanent frame work of tin plate; the movable cam axles, *AB* and *CD*; the driving wheels or pulley cones, *EF*, with belt and crank, and the removable back plates, *GG* vertical and *H* horizontal.

The framework of the rectangular shape seen is made up of strips of tin plate bent into an elongated *C*-section, as shown in Figure 7, firmly soldered together and screwed down to the baseboard. The uprights which carry the axles are similarly made, fastened and suitably braced. A very light and open but strong frame is thus obtained which could be used even without the board. The slight yielding which remains is rather an advantage.

The hollow cam axles *AB* and *CD* of brass, about 25" long, parallel and 15" apart at the same height, are sustained at the ends *A* and *C* by pins *a* and *c* secured by metal straps of copper at the ends of the uprights. The pins project about 1" or 2" into the axles, so that the latter may revolve around them securely. The ends *B* and *D* of the cam axles similarly receive the reduced and shouldered axles of the pulley cones *E* and *F*, and spring latch pins (one visible at *D*, and in Fig. 2 at the other figures) fasten the pulleys rigidly to the respective cam axles.

Detached cam axles are shown in Figure 2. The pulleys are grooved so that the speed ratios 4:2, 4:3, 4:4, 4:6 may be imparted to the axles by successively moving the belt from front to rear. They are mounted in a horizontal rectangle on four uprights corresponding to axles at the corners, and any tension given to the belt bears longitudinally upon the rectangle without straining framework. The rectangle is wide enough to allow the pulleys to slide laterally when-

*The edge around which the plate is bent should be rounded. Sharp bends are not wanted.

ever a cam axle is to be removed. This is done for the front axle, for instance, as follows: Let the metal strap at *c* be loosened and the pin therein withdrawn; this frees the end *C*. Now let the spring latch at *D* be withdrawn and the axle of pulley *F* slid to the right. This frees the end *D*. The cam axle may now be withdrawn to be replaced by another on reversing these operations.

3. *Cam axles*.—Each of the cam axles (Figs. 1 and 2) carries 25 eccentrics of thick tin plate, equidistant, about 1" apart and differing in phase by $\frac{1}{2}$ circumference in Fig. 1, so that in this case there are two complete right-handed turns in each of the helices. The diameter of the rear eccentrics is 4", with a double swing of 3"; the diameter of the front eccentrics is 3", with a double swing of 2", but this series has an advantage of position or leverage, as will presently be seen. A safe minimal margin of $\frac{1}{2}$ " beyond the axle is thus left in each case.

It is usually convenient to keep the rear axle in place. In the room of the front axle, however, the other right-handed helices (Fig. 2), containing respectively 1 or 3 turns to the whole length; another containing one right-hand and one left-hand helix (the eccentrics alternating), and a final one left-handed, with 4" cams and 3" throw, corresponding to the rear axle (see Fig. 6), are provided. The two latter are adopted for the illustration of rotary polarization. The three former are a means of obtaining wave-length ratios 1:1, 1:2, 2:3 for all amplitudes, periods and phases on removing the front axle only.

The general purposes of the machine will not require more axles than this, though I have used others to be referred to below.

The eccentrics themselves of the heavy tin plate specified are turned together to a common size on the lathe, and soldered to the axle by aid of a suitable gauge. This

need merely be a piece of board of a width corresponding to the distance apart of the cams, and having the phase angle carefully marked on both sides. If the board is perforated normally for the reception of the axle, and cut across axially so as to be removable, the soldering of the cam axles is surprisingly easy. I have also tried other methods with success. The work must be done expeditiously, as prolonged heat warps the cams.

The helices shown in the figure are usually right-handed screws. Since they are stationary, a wave advancing from the operator corresponds to counter-clockwise rotation. This is an apparent disadvantage as compared with left-handed stationary screws, but as the waves in the former case advance from left to right (positively for the observer in front) for clockwise rotation by an operator on the right of the machine the disposition chosen is preferable.

4. *Levers, Riders and Balls*.—To obtain the different types of wave motion from the cams described, long extensible levers of thin brass tube are provided, shown in detail in Fig. 8 (longitudinal dimensions $\frac{1}{2}$, cross dimensions $\frac{1}{4}$), and in place in the remaining figures.

The levers were originally made of heavy guttered tin plate behind and light guttered tin plate in front. Latterly, however, I replaced these by the light extensible 'curtain rods' of very thin brass tube,* consisting of a round tube *E* snugly telescoping into a wider round tube *FF*, about $\frac{5}{16}$ " in diameter. The first tube *E* is provided with an axial pin *R*, 3" long, carrying a $\frac{1}{2}$ " cork ball *Q* (painted red), representing one of the vibrating particles of the wave. The rod *R* is not seen in sunshine shadows and is added for this reason. Its end is tipped

* These 'rods' are in the market, each about two feet long, thus admitting of a safe extension to much over three feet. Though made of thin split tube, they fit well. The price is trifling.

with an eyelet (not shown), to actuate other apparatus §§8, 25, 24.

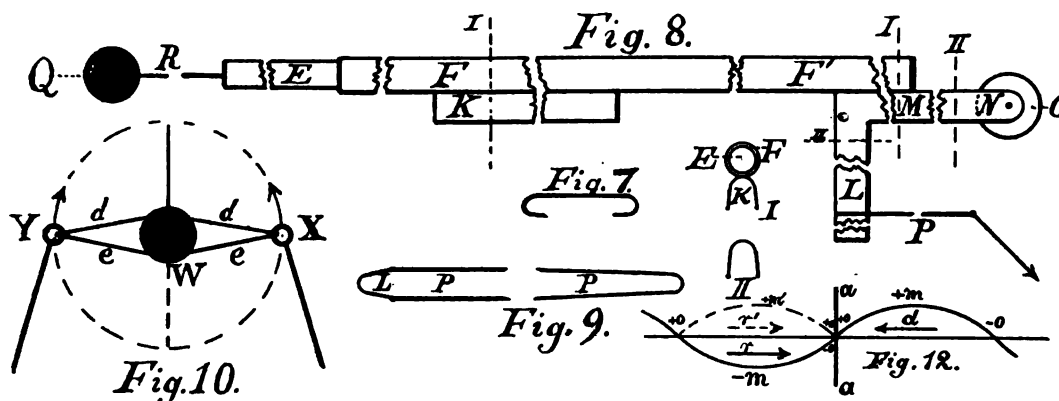
The larger tube FF' carries a U-shaped wide gutter of tin plate K in front, soldered to FF' and adapted to ride on one of the front series of eccentrics. The section through I is seen in the auxiliary figure I , showing all the sectional parts E , F , K in their relative positions. K is $7\frac{1}{2}$ " long and must be carefully placed so as to be adapted to the various types of wave motion. Its position in figure is in the scale specified.

The rear of the tube FF' is fitted with a similar set of gutters of tin plate, M and L , meeting at right angles with their concave sides rearward and downward. This right-angled gutter is adapted to ride on one of the cams of the rear axle, the bearing being on M or L , or both, as the case may be. The section is shown in II . The gutter M terminates in a flat fork, securing and guiding a small vertical roller O , as shown in the figure.

common cross rod (seen at S in Figs. 4 and 5), and they are adjusted as to tension and direction by sliding both ends of the rod S along oblique notched laths of tin plate T on both sides of the machine. The springs themselves appear clearly in Fig. 4, and the riders in different positions in the other figures. The cams in rotating run within the loop of the elastic staple P , and sufficient breadth must be given for clearance. The springs should be as light as practicable to obviate excess of friction on the axle. Steel wire No. 23, wound to a closed helix about $1\frac{1}{2}$ " in diameter and $1\frac{1}{2}$ " long, is suitable.

The length of the gutter L is 6", of M to the end of the roller $7\frac{1}{2}$ ", and they are soldered to F' to correspond with K .

As regards sure guidance and ease of adjustment, springs placed in the rear of the machine are to be preferred. With less advantage they may be placed between the axles, as was done in my



FIGS. 7 TO 10. Details.

FIG. 12. Diagram.

To bind the levers firmly down upon the rear cams, a long staple of thin steel wire (No. 16) P is attached about 5" below FF' . As shown in plan in Fig. 9, this is about 5" long and pulled downward to the rear by a helical spring the action of which is indicated by the arrow in Fig. 8. The rear ends of all helical springs are soldered to a

earlier apparatus. Levers heavier at their rear ends are desirable, and in some experiments, if not in all, the machine should be tipped up in front. Waves may then be sent along the axis with considerable velocity.

ACTION OF THE MACHINE.

5. *Method of Compounding.*—Very little

need be said about the action of the machine. It is clear that if the rear ends of the levers are horizontally at rest, but execute S. H. M.* in the vertical by riding nearly parallel to themselves on the rotating cams, the balls Q would execute similarly approximate S. H. M. if the fulcrum K were a common axis for all; but if the fulcrum K , though horizontally at rest also executes S. H. M. in the vertical the motion at Q will be the complex harmonic of which the two stated motions (M and K) determine the components.

Again, if the rear end of the lever is vertically at rest, but executes S. H. M. in the horizontal by leaning against the rotating cams rearward (rider L), the ball Q will do the same provided the slide at K is in a parallel plane; but if the rider K simultaneously executes S. H. M. in the vertical the motion at Q is the complex space harmonic corresponding to the two components stated, etc.

Finally the wave-length ratio is given by the cam axles; period ratios are determined by the pulleys or by the velocities of rotation imparted to those axles, respectively; the cam axle and pulley ratios together then determine the velocities of propagation of the component waves.

6. *Plane Transverse Waves*.—With these explanations the remaining figures will be intelligible.

Fig. 3 is the arrangement for plane polarization. In this case all the levers abut at their rear ends against the vertical plate G , with freedom to slide up and down it in virtue of the rollers O (Fig. 8) when the wave is in motion. Grooves for O are an advantage. Riders K and M are here in action, rider L being kept quite in front of the cams by the plate G . The levers are continually pushed to the rear by the clockwise rotation at the crank, and additionally by the rearward action of the springs.

*Simple harmonic motion.

A notched lath (not shown in the figures), stretching quite across the machine between the axles and swung horizontally and upward on a swivel, is adapted to lifting all the levers at once quite above the front cam so as to permit the easy insertion of another cam axle. Riding on this rail the levers show the simple harmonic due to the rear axle alone.

7. *Transverse Space Waves*.—The machine is adjusted for space waves in Fig. 4. Here the rear ends of the levers are lifted so as to roll in the fore and aft grooves of the horizontal plate H in virtue of the rollers O . Riders M are lifted quite above the cams, while riders KL and the grooves on H now control the motion, the levers being drawn rearward by the spring. The figure shows a circularly polarized wave passing along the particles, being compounded of the horizontal rear wave seen on H and the vertical wave above the front axle. Of course, an inspection of the apparatus is more satisfactory.

In a recent construction I have modified the rear plates G and H , discarding H and adopting G in such a way that it may be slid from its vertical position into the horizontal position (H) by following lateral guides much like the platen of a printing press. The plate now carries all the rear ends of the levers with it, which much facilitates the change from plane to space waves and *vice versa*. The grooves on the plate are preferably much wider and deeper than shown in Figure 4.

In Fig. 5 the machine is in the act of compounding the circular motion of the rear axle with the vertical S. H. M. of the front axle. The back plate is wholly removed and the three riders KML (Fig. 8) now come into play. The figure shows the horizontal S. H. curve, resulting for opposite phases of the vertical components. S. H. structure above the front axle and the circular harmonic arrangement of the rollers in the rear is manifest.

8. *Compressional Space Waves*.—Either of the adjustments, Figs. 4 and 5, is adapted to actuate sound waves, as will be shown below, § 25.

9. *Rotary Polarization*.—Figure 6 shows the apparatus adapted to compound two equal and opposite circular motions, Fig. 10 being a detail relative to it. Both the front and rear series of eccentrics have the same diameter and swing, but there is one turn in front to two in the rear, respectively left and right. The riders are gutters about 4" long, joined at right angles with the concave sides toward the eccentrics. The extensible levers (tubular as above) are soldered in the prolongation of the bisectrix of the riders, and project from the salient side of the right angle obliquely upward, each passing through a perforation in the horizontal laths of folded tin plate shown at $U U'$ and $V V'$. The levers are effectively about 18" long, and are held down upon the cams by springs * (like the above), one end of each of which engages the lever, while the other is revolvably attached to the axle, between the cams (see Fig. 6). If $U U'$ and $V V'$ (adjustable) are symmetrically placed with reference to the two effective ends of the levers the upper ends will trace a circle-like figure, corresponding to the circular motion of the lower ends. With the pulleys cross-belted as shown, the pin eyelets $X Y$ (3" long, soldered axially to the upper ends) may then be adjusted to the counter circular motion indicated in Fig. 10.

Two methods of compounding were tried. In the first the ends of two silk threads, Fig. 10, carrying the cork W (vibrating particle) between them were fastened to delicate helical springs surrounding the upper ends of the levers. This method constructs the wave very well, but in motion the friction at the eyelets (one of which is often high and the other vertically below

* These springs are seen on the helix in Fig. 2.

it) is apt to be too unequal to keep the particle in the symmetrical position necessary. Better results are obtained by stretching a very thin India rubber band, $dd ee$, between the eyelets, carrying the particle as before. Springs were similarly tested. Parallelogram motion is hardly appreciable here without elaborate construction.

The vertical vibration is in this way very well obtained (of course, in semi-amplitude). The horizontal vibration is noticeably curvilinear, seeing that the two motions compounded are not quite uniformly circular. Even in this case, however, the connectors $dd ee$ move parallel to themselves.

The helical characters of the wave obtained is well shown in Fig. 6, calling to mind that each ball vibrates normally to the strings by which it is suspended.

The laths $U V$ are supported by uprights $Z Z'$, which fit in flat sockets (seen at J , in Figs. 4 and 5). With these the whole superstructure of laths, levers and riders is removed from the machine at once in a manner easily suggested. The bed plate then returns to the appearance of Fig. 1.

The method of obtaining similar results in compounding circular motion for the case of Fig. 4 is given below § 24. A special cam axle carrying two screws (alternate cams differing 180° in phase) is here needed. If rotary polarization is wanted the wavelengths of the front and rear axle must differ.

EXPERIMENTS.

10. *Method of Designating Phases*.—Before describing the consecutive experiments to be performed with the machine, it is well to come to an understanding as to the phases in which the two component disturbances meet. These are conveniently determined by the *long axes* of the first eccentrics on each axle, which (axes) may, therefore, be called pointers. Since the waves for clockwise rotation at the crank travel from left to right, along the axle, and since a rise of

the front cams elevates the balls, whereas a rise of the rear cams depresses them, the two component waves will meet in the same phase at the origin when the long axes of the eccentrics there point horizontally away from each other, *i. e.*, when the front pointer is to the front or left of the operator at the crank, and the rear pointer to his right. This is also the null position, or zero of phase (to be marked $+0$), for the first particle of each component wave, *i. e.*, the particle on the left hand (origin) of the observer facing the machine in front. Both component harmonic curves and the com-

of both axes over 1, 2 and 3 right angles, while the compound harmonic is shoved forward $\frac{1}{2}, \frac{1}{2}, \frac{1}{2}$ wave-length. Further rotation of 90° restores the original case.

If the two cam axes contain the same number of turns, the same phase difference obviously corresponds to all particles. Otherwise special consideration is necessary for each case.

Restoring the front and rear cam axes to their original positions (pointers horizontally outward), rotate the rear axle 90° , clockwise, relative to the other. This puts all its particles 90° ahead in phase of the

TABLE OF PHASE DIFFERENCES. CLOCKWISE ROTATION OF AXLES, POSITIVE. DISPLACEMENTS OF PARTICLES UPWARD AND REARWARD, POSITIVE.

Transverse Plane Waves.	Transverse Space Waves.	Front Axle.	Rear Axle.	Front Axle.	Rear Axle.	Front Axle.	Rear Axle.	Front Axle.	Rear Axle.
Same Phases.		+0	+0	+m	+m	-0	-0	-m	-m
	Front } +270°, Rear } +90° Axle } Axle }	+0	+m	+m	-0	-0	-m	-m	+0
Front } +90°, Rear } +270° Axle } Axle }		+0	-m	+m	+0	-0	+m	-m	-0
	Same Phases.	+0	+0	+m	+m	-0	-0	-m	-m
Opposite Phases.		+0	-0	+m	-m	-0	+0	-m	+m
	Front } +90°, Rear } +270° Axle } Axle }	+0	-m	+m	+0	-0	+m	-m	-0
Front } +270°, Rear } +90° Axle } Axle }		+0	+m	+m	-0	-0	-m	-m	+0
	Opposite Phases.	+0	-0	+m	-m	-0	+0	-m	+m

pound harmonic leave the origin with a descending node, the head of the wave (right semi-wave) being a crest. Absence of phase difference in the component harmonics of the particle at the origin will occur for other cardinal positions of the pointers, *viz*: front and rear pointers respectively up and down (maxima, marked $+m$), right and left or towards each other (mean position marked -0), and down and up (minima, marked $-m$). These follow each other on like clockwise rotation

corresponding particles of the front wave. The pointers in their cardinal positions will now be respectively left and down, up and left, right and up, down and right to the operator, etc., for successive additional rotations of 90° each.

Beginning again with pointers away from each other, *i. e.*, with both component, S. H. motions starting at the first particle, let the front axle be rotated clockwise 90° relatively to the other. The pointers in their cardinal positions will now be up and right,

right and down, down and left, left and up, while the particles at the origin run through all phases together. This case corresponds to the preceding for 270° , etc.

All this is evident enough; but it is, nevertheless, advisable to make a diagram of the position of the pointers as here shown, in order instantly to discern the phases in which the initial particles meet in any case. In the table the positions of the pointers are designated by arrows; $+m$ denotes maximum displacement, etc. Further explanation will be given presently.

11. *Space Waves*.—The composition of two simple harmonics at right angles to each other will necessarily require special treatment, for here the rear riders are at right angles to those of the former case, and the S. H. motion of the rear axle is not reversed at the balls. If displacement up and forward from the observer's view be considered positive, then the null position or zero of phase of the particles at the origin corresponds to pointers left for the front axle and up for the rear axle, as seen by the operator. The compound simple harmonic of these components is thus a linear vibration with amplitude $\sqrt{2}$, as regards the equal components, and making an angle of 45° to the horizontal from the observer to the machine. It thus lies in the first quadrant, as seen by the operator at the crank.

Both component S. H. curves leave the origin with a descending node.

Hence, if in the above table we shove the first column of entries one row ahead, *i. e.*, if we begin for no phase difference with the second row and continue in cyclical order, the table will be adapted to the present case. Pointers in opposite directions will thus correspond to counter-clockwise circular motion in the compound wave; pointers in the same direction to clockwise circular motion, as seen by the operator at the crank. The first of these cases will, however, correspond to a right-handed, the second to a

left-handed, screw when seen from the origin, since all waves move from left to right.

The table contains an entry relative to the present case. It thus indicates 16 cardinal phase differences for plane and the same number for space waves.

12. *Effective Circles of Reference*.—Finally, a word may be said as to the position of the circles of reference corresponding to the two component S. H. motions. Clearly, the centers of the eccentrics (marked in Fig. 1) determine the amplitude of the S. H. M. In all phases, however, the riders are nearly normally above or else to the rear of these centers by a distance equal to the radius of the eccentric, and, therefore, always in the same kind of reciprocating motion which corresponds to the amplitude and period of the eccentric.

Hence the circle of reference of the vertical S. H. M. is on a vertical diameter and tangent to the highest and lowest positions of the edge of the eccentric on the same side of the axle. The diameter prolonged passes vertically through the cam axis, and its length is twice the throw of the center of eccentric. This circle of reference for the horizontal S. H. M. of the riders (displacement $+$ rearward) is on a horizontal diameter and tangent to the extreme right and left positions of the edge of the eccentric on the same side of the axle.

The amplitude of the vertical vibrations is modified by the lengths given to the extensible levers. If l be the lever length between the axles and l' that beyond the axles, and if a , a' denote the front and rear amplitude at the eccentrics, then the effective amplitude at the particles will be $a(l + l')/l$ and $a'l'/l$, and their ratio

$$\frac{a'}{a} \frac{l'}{l + l'}$$

may be varied at pleasure from zero to about $9/8$, since l' is the extensible part. Usually the ratio one is desirable.

The amplitudes of the horizontal vibrations do not admit of change without giving useless complexity to the machine. Advantageous lever ratios will be given with the experiments.

I. *Component S. H. Motions Coplanar, of the same Wave-Length.* 13. *Plane Polarization.*—Let cam axles each with two complete turns be selected and the rear plate adjusted to the vertical (Fig. 3). For harmonic curves this implies the same wave-length for the coexisting S. H. motions. With the cams swinging nearly as 2:3, and lever ratios $l + l'$ and l' (§ 12) as 3:2, the occurrence of no displacement along the line of particles may be looked for in case of opposite phases. This furnishes a method of adjusting the particles at the outset. Practically the condition of no displacement is reached with relatively short levers, say a meter long. When the pointers on the initial cams are away from each other the components meet in the same phase, with the first particle in the axis of motion just about to start vibrating. The double amplitude given by the machine to this compound harmonic (25" long) of maximum displacement is about 9". If a beam of parallel rays (sun light) be shot along the axis of the wave, the shadow of the balls on a screen normal to the axis necessarily betrays slight curvature; the double amplitude, instead of being vertical and straight, is concave toward the cams. But the chord deviates from the arc (9") by less than $1/2$ " at the center, and hence with balls $1/2$ " in diameter the curvature is negligible to the eye of an observer in front. It must be remembered, however, that curvature is superimposed in all subsequent higher figures.

If the front cam axle be dephased 90° clockwise the amplitude of the compound curve is diminished, the curve remaining sinusoidal but beginning with $1/8$ wave-length. If the rear cam axle is also de-

phased 90° clockwise the compound curve of the first case is restored in the shadow (maximum amplitude), but the phase of the first particle has advanced $1/4$ period and the curve itself $1/4$ wave-length, etc. I allude to these points because of their value in instruction. (Cf. table, § 10.) By the very make-up of the machine a S. H. curve is seen to result when the phase difference of two particles varies as their distance apart. In drawing such a curve it is simpler to place the circle of reference in the plane of the harmonic; in the machine the circle of reference is preferably placed at right angles to the curve. The addition of two such curves is another S. H. curve of the phase and amplitude directly specified by the machine.

14. *Waves of Constant Amplitude.*—Belting the two equal pulleys and rotating uniformly, waves corresponding to each of the harmonic curves produced in § 13 may be sent along the axis of motion. Thus making the phase difference between two particles proportional to their distance apart, and then setting each particle in S. H. M. of a common period and amplitude, is objectively seen to be the realization of simple wave motion. The wave-length being fixed by the apparatus, velocity and period must vary reciprocally.

Particularly striking is the case for opposite phases in the two wave cams. Both component waves are seen travelling in the same direction along the axes with full vigor, whereas the compound effect at the line of particles is permanently nil.

The warped surface of the levers now has a linear directrix at the particle edge and a sinusoidal directrix at the roller edge. It should be noted that the case of maximum amplitude in the compound harmonic presents an approach to a similar linear directrix between the cam axles.

15. *Waves of Varying Amplitude.*—Change of amplitude is given to the levers by draw-

ing out the front tube (§12). Additional change may be obtained by allowing colored balls to ride on the levers. In case of equal periods the result is chiefly interesting when the amplitude varies from particle to particle. A linear variation is well represented by a plane wave oblique to the direction of the axes, and in action is very striking.

The more important wave with an exponentially varying amplitude is only given when the axis of motion is along the corresponding exponential curve horizontally, but the effect to an observer at a little distance in front is none the less good.

II. *Preceding Case (I) with Additional Velocity Superimposed on Either Wave Train.* 16. *Beats.*—If the component waves are transmitted in like periods or velocities* and amplitudes, the compound wave is transmitted unchanged in form; but if any of these quantities vary, the compound wave continually changes form. With the apparatus as here adjusted the last case is readily realized by sending on one wave faster than the other. For instance, if the component wave velocities be as 3 : 4 (rear wave of greater speed), then in 4 complete turns at the crank the original wave will be reproduced, while all intermediate phase differences between corresponding particles are passed continuously in turn. All pairs of cams are undergoing like continuous change of phase.

The shadow picture of this case (sunlight) shows a line elongating to maximum displacement and then contracting to a point in S. H. M. The slow change at maximum elongation is in strong contrast to the rapid change of length on passing through the position of equilibrium. Similarly in §14 the speed ratio must be carefully adjusted if the linear compound wave is to persist.

* In the present special case variation of one implies the other; in the sequel, period and velocity must be carefully distinguished.

The wave corresponding to this present experiment is an excellent example of an infinite beating wave train, two wave-lengths of which are accessible at a given place. The beats are due to a difference of wave velocity and frequency together. Though the two cases are usually generically different, the gross effect is here coincident. As a luxury a cam axle containing a small fraction of a wave-length more than two complete wave-lengths might be supplied. This would then show beats due to difference of wave velocity for the same period or (with the proper pulley) beats due to difference of period for the same wave velocity. The specific difference is this, that, whereas in one case (equal component wave-lengths) the compound harmonic is at every instant (for all pulley ratios) sinusoidal, in the other case (slightly different component wave-lengths) it is at no instant strictly so. The latter adjustment thus admits of beats either when the component periods alone or the component wave velocities alone are not the same. In the former both necessarily change together.

17. *Döppler's Principle.*—If the beats are obtained by a difference of wave velocity the faster wave may be treated as having an additional linear velocity *virtually* impressed upon it in the direction of motion from without. Its interference with the wave not so affected is then an illustration of Döppler's principle.

III. *Preceding Cases (I and II) with the Velocity of Either Wave Train Reversed.* 18. *Equal Velocities. Stationary Waves.*—If one of the component waves be passed along the axis positively and the other in a negative direction, i. e., if one axle be rotated clockwise and the other counter clockwise by cross-belted equal pulleys, the compound wave is of the stationary type, since amplitudes were made effectively equal and periods are necessarily equal. The effect on the machine is striking, since the nodes are

here indicated by stationary particles half a wave-length apart, while the antinodes vibrate 9". In all positions the form of the compound harmonic curve is at all times a simple sinusoid, but its mode of motion as compared with the same curve while both components are direct is totally different.

Again, if the first pair of cams are in the same null phase (pointers away from each other) the first particle is a node, succeeded by four other nodes one-half wave-length apart, and the wave is initially at maximum amplitude. If the first pair of cams are in opposite null phases (± 0) the initial harmonic curve is linear, the first of four nodes one-fourth wave-length ahead, etc.

Reflection.—The first of these cases corresponds to reflection from a denser, the second to reflection from a rarer, medium at the origin. It is worth while to examine the interpretation of both cases* for transverse waves first, and thereafter, §26, to similarly treat longitudinal waves.

If the direction of a wave is reversed, particles without displacement (± 0) are changed half a period in phase (becoming ∓ 0); particles at maxima or minima ($\pm m$) are not changed in phase at all, while the phases of intermediate particles are changed in the corresponding harmonic ratio. This may be tested at once by supposing the full wave, Fig. 12, to advance first in direction d , thereafter in direction r , when the particles vibrating in the line aa will respectively rise and fall, thus passing between opposed phases; etc.

The transverse wave advances through a given medium at rest, with the zero of displacement (± 0) in the wave front, so understood. Hence to reverse the direction of a wave is to reverse the phase of the wave front.

If the transverse wave encounters a denser medium this implies that the particles therein situated are capable of reacting with

forces in excess of those corresponding to the original medium. If the medium is quite impermeable (as when the wave on an elastic cord meets the peg) the reaction is exactly equal and opposite to the action. Thus if a wave advances toward the dense medium with a crest or group of pulls upward the medium itself must at every instant react with equal pulls downward. This reaction, which in its succession is bound to be rhythmic like the impinging wave, is the impulse of the reflected wave, which must all be returned into the first medium (*i. e.*, be reversed in direction) if none can enter the new medium.

Now, let the particle in the wall aa (Fig. 12) be in the zero of phase ($+0$). The direct wave advancing, as shown by d , is in the act of increasing the displacement. It is developing an increasing pull up. The reflected wave (prolonged) r is simultaneously in the act of developing the counter pull down; it is, in like degree, tending to decrease displacement: but, though the phases impressed by the direct and reflected wave are thus initially quite opposite, both waves d and r momentarily constitute contiguous parts of the same harmonic curve. If this curve separates at aa , with the parts d and r moving with equal velocity in opposite directions the condition for action equilibrated by reaction at aa is maintained throughout all time.

The explanation is essentially the same if the reaction is not complete (permeable dense medium). In this case the amplitude of r will be smaller, other conditions remaining the same.

Hence in the machine the pointers are to be set for equal and opposite displacements at the origin, beginning with the null phases of each component wave—the case of Fig. 12, where if d and r were moving in the same direction, or the pulleys not cross-belted, the two components would meet in the same place.

*Waves as here considered are essentially steady.

On the other hand, if the direct wave meets a rarer medium at *aa* the reaction is less than that of the original medium. The pull up developed by the wave *d* in Fig. 12 is not resisted by an excessive pull down as before. The reaction (which from its rhythmic character develops the reflected wave) is an additional pull up, such as would correspond to a wave *r'* in Fig. 12. Both waves *r'* and *d* are in the same phase as regards their effect on the initial particle at *aa*, but they differ in direction of motion. In other words, the direct wave *d* and the reflected wave prolonged *r'*, are not initially contiguous parts of one and the same wave, meeting without displacement at the wall. Half a wave-length is necessarily lost at the inception.

This determines the method of setting the pointers of the machine for equal displacements of the same sign at the origin, beginning with opposite null displacements; for the two waves *d* and *r'* if traveling in the same direction (cf. Fig. 12) would then annul each other.

Summarizing; the reflected wave from a denser plane boundary normal to the axis is obtained from the incident wave by *two* rotations of 180° each; one around the axis of motion, the other around the trace of the wave plane on the plane of the obstacle; these correspond respectively to the substitution of reaction for action, and of an opposed direction for the given direction of motion—two reasons for change of phase. The wave advancing *crest on* (crest foremost) returns *trough on* and *vice versa*.

The reflected wave from a rarer plane boundary is obtained from the incident wave by a *single* rotation around the trace in question. The only reason for change of phase is change of direction. The wave advancing *crest on* returns *crest on*, and the *trough* returns a *trough*. Cf. §26.

If the component amplitudes are made unequal the nodes show a correspondingly

slight vibration, the case corresponding to a medium at the origin neither absolutely impermeable nor absolutely rare.

19. *Wandering Nodes*.—If with equal amplitudes the velocities or periods of the components be unequal in value and opposite in sign the case becomes one of stationary waves with continually drifting nodes. Thus if the 3:4 pulley be cross-belted four turns of the rear or faster cam axle will continuously move the node half a wave-length onward. The stationary character is, nevertheless, very thoroughly retained.

In the extreme and transitional case where the velocity of one wave is zero and the other of any value a single turn at the crank moves the nodes half a wave-length and thus reproduces the original curve.

IV. *Component S. H. Motions at Right Angles to Each Other of the Same Amplitude and Wave-Length*. 20. *Elliptic Polarization*.—Using cam axles with two waves each and adjusting rear ends of levers (Fig. 4), while the vertical riders *L* engage the cams, two simple harmonic curves are available to be compounded at the particles. This is usually an elliptic helix. It is advisable to tip the machine up in front with the object both of relieving the work of the springs and of exhibiting the wave symmetrically with reference to a horizontal plane through the axis.

In order that circular polarization may be obtained, the amplitudes of the particles must be equal. The rear cams contribute their full swing independent of the levers. The fore cams enter with an amplitude which may be more than doubled, though the fulcrum of the levers is now at the rollers. Thus the levers are to be shortened from 1 meter to about 70 cm. to obtain circular paths 3" in diameter for the single particles. Shorter levers would give oblate ellipses, larger levers prolate ellipses, for their central figures. Cf. §36.

The two S. H. motions will meet and

exist throughout in the same phase if the pointer on the rear eccentric is 90° ahead of the other, supposing, in accordance with the above table, that directions upward and rearward are positive. The zero of phase thus begins with front pointer left and rear pointer up. If the pointers are parallel and in the same direction the front harmonic is 90° in phase ahead of the other. The compound harmonic is circularly polarized and the corresponding wave advances with counter-clockwise rotation if seen in the direction of advance, *i. e.*, from left to right to the observer in front. Dephasing the front axle 90° farther (180° advance) produces plane polarization at 135° to the horizontal; 90° farther (total advance 270°) finally a circularly polarized harmonic curve with a wave advancing in the direction of the components with clockwise rotation, as seen from the origin. All intermediate cases are elliptically polarized with intermediate rotation.

The sunshine picture on a screen normal to the axis with rays parallel thereto is in general an ellipse with the appropriate rotation discernible with remarkable clearness.

V. Preceding Case (IV) with Component Velocities or Periods Unequal. 21.—If the component waves do not advance with the same velocity (necessarily implying difference of period in the present case) the difference of phase of the first pairs of cams is continually changing, and the phase difference of all succeeding cams is changed in like measure. Hence the compound wave passes continuously through all the different harmonic curves in turn. If the belt be placed on the 3:4 pulleys four turns of the rear axle restores the original form through all intermediate forms, beginning, for instance, with plane polarization at 45° , passing through circular clockwise polarization (seen from the origin) into plane polarization at 135° ; then back with

counter-clockwise rotation into plane polarization at 45° .

The sunshine shadow of this case is identical with the Lissajous figures from two tuning forks slightly different in pitch but of the same amplitude. The directions of rotation are particularly evident, enhancing the instructiveness of the figure.

VI. Preceding Case (IV.) with Either Component Velocity Reversed. 22.—If with equal amplitudes and wave-lengths the component waves travel in opposite directions (pulleys cross-belted) the compound wave is a peculiar form of stationary wave in which the form of vibration of all particles is sustained, but in which the motion of each particle differs uniformly in regard to the phase difference of its components, *i. e.*, in ellipticity, from its neighbors. Thus a group of particles a wave-length apart are plane polarized at 45° ; particles midway between plane polarized at 135° ; particles midway between both groups circularly polarized with alternately opposite rotations and all other particles correspondingly elliptically polarized. The envelope of the harmonic curve would be given by a thin tube 3" in diameter, compressed at equal distances by a pair of shears to lines at right angles to each other, but alternately in the same direction. The case is thus thoroughly different from the case of unequal velocities in the same direction, where all the particles under observation are instantaneously in the same ellipticity.

23. *Velocities Reversed and Unequal.*—If the two component waves of the same wave-length have unequal velocities (and periods) of opposite sign the plane polarized groups wander. Thus if the 3:4 pulleys be taken 4 turns of the rear crank reproduces the original wave. The transitional case is again that in which one cam axle is stationary (wave velocity zero) while the other rotates. A single turn reproduces the original figure.

VII. *Preceding Case (IV.) Adjusted for Rotary Polarization.* 24.—If a special axle be provided with the cams alternately in opposite phase to the normal occurrence, but otherwise equal in amplitude and wave-length, and if the corresponding balls be painted red and white, the two circularly polarized waves occur simultaneously. Similarly, the two plane polarizations at 45° and at 135° occur simultaneously; etc. The former case is interesting in relation to rotary polarization, as will be more fully indicated below; for the two circular motions may be compounded by the device shown in Fig. 10, and a harmonic curve plane polarized in the vertical or the corresponding wave will result (cf. §40 *et seq.*).

To obtain rotation of the plane of polarization by this method the alternate cams on both the front and rear axle would have to be set for some other wave-length in the manner stated.

(vertical) axes of which are at the angles of the cranks, as far apart as the cams, and all arranged along a straight line parallel to the cam axle. The short shanks of the bell cranks now carry a series of $\frac{1}{2}$ " balls, which, under present conditions, must, therefore, vibrate nearly parallel to the cam axes, *i. e.*, longitudinally right and left in the line of advance of the wave, whereas the thrust of the levers* is harmonically to and fro.

In practice the long shanks are open sectors of wire, swung so as to clear each other's axes.

In this way the alternate compression and rarefactions of such a wave are remarkably well shown (cf. Fig. 11), the sinuosity in the line of particles being negligible at least to the observer in front. The balls approach each other to about $\frac{5}{8}$ " between centers (all but contact in the compressional phases), while they sepa-

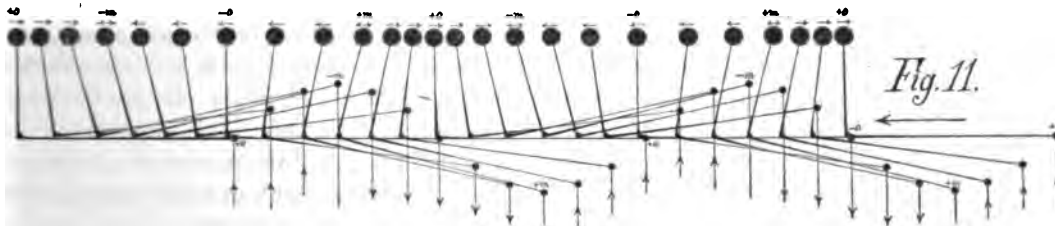


FIG. 11. Adjustment for compressional waves, seen from above. Diagram. Wave advances from left to right to an observer in front. Lever displacements positive rearward. Ball displacements necessarily reversed.

VIII. *Waves of Compression and Refraction.* 25. *Longitudinal Vibration.*—With the apparatus arranged as in Fig. 4, let the levers all be raised at the front ends, so as quite to disengage them from the front cam axle. This being, therefore, out of action, the rear or horizontal harmonic of 3" double amplitude forward and rearward thrust is alone in play, as shown in plan by the parallel lines normal to the axis in Fig. 11. Now, let the ball ends of the levers (eylets) engage the long shanks (6") of a series of horizontal, right-angled bell cranks, the equidistant

rate to more than about $1\frac{3}{8}$ " in the rarefied phases.

The great advantage of an arrangement of this kind from the kinetic point of view is the direct evidence furnished that each ball in the first instance is actually in S. H. M., and that the phase difference between balls is proportional to their distance

* The reader should remember that Fig. 11 is seen from above and that direction rearward in the transverse harmonic (down in figure) is positive wave velocity left to right in the machine, becomes right to left in figure. Balls in front reverse their positive motion.

apart, while the compression and rarefaction of such a wave is an incidental phenomenon. This essential structural character of the acoustic wave is not generally enough insisted on.

In the same way any of the above or the following complex plane polarized waves may be converted into compressional waves by using vertical bell cranks (horizontal axes). For the case of stationary waves this would be of some interest, but I have not carried out the construction. Since small displacements are wanted, the engagement of levers should be located between the axes.

26. *Reflection.*—There is bound to be confusion if the reflection of a compressional wave from a denser or a rarer medium is to be explained without reference to the elementary S. H. M. of the particles of such a wave. Relatively to § 12 and Fig. 12 it follows that the explanation there given is at once applicable to S. H. M. in sound waves, the only difference being that for pulls up and reactions down we have now pulls toward the right and reactions toward the left, etc., which in no way modifies the reasoning. A wave advancing toward the dense medium 'crest on' returns 'trough on'; advancing toward the rare medium with a crest returns a crest. Let no one suppose, however, that crest and trough mean compression and rarefaction. For it is just here that a slough of despond awaits the incautious interpreter. A glance at Fig. 11, where the oscillations of particles have all been marked, shows that the centers of compression and of rarefaction are without simple harmonic displacement (phases ± 0); that the maxima and minima of displacement ($\pm m$) lie in air of normal density. If the wave is to advance with particles in the wave front in the zero of displacement it must advance the center of a compression or the center of a rarefaction sharply into normal air. Thus, the particles on one

side only of the balls marked ± 0 in Fig. 11 must indicate the status of an advancing sound wave; moreover, if the former begins a crest, the latter (particles on the other side of ± 0) begin a trough, and *vice versa*.

In this structural fact lies the gist of the true explanation: If a compression meets a denser medium it is reflected as a compression surely enough, but the two compressions are not the same. The symmetrical half of the incident compression is returned. The two halves lie on opposite sides of no displacement, and are the contiguous halves of crest and trough required by Fig. 12. So the two symmetrical halves of a rarefaction become incident and reflected wave, initially meeting the plane of reflection as contiguous trough and crest. In both cases crest returns trough, and trough crest, even though two compressions or two rarefactions are in question.

If reflection takes place from a rarer medium a compression returns a rarefaction; this, however, is the rarefaction ending in a crest, while the given compression begins one, and *vice versa*. In other words, there are two crests advancing in opposite directions; or crest returns crest, even though a half wave-length is initially lost and though a compression returns a rarefaction.

The agreement with § 12 is thus complete and the whole explanation logically simple throughout.

IX. *Component Simple Harmonics Coplanar, with Wave-Length Ratio, 1:2. Harmonic Curves.* 27.—Replacing the front cam axle by another containing a single wave-length and 2" double amplitude, the plane compound harmonics for period ratio 1:2, for the same or different amplitudes and for any difference of phase, may be exhibited in succession. The cams are exchanged by lifting all the levers above the front axle, by aid of the notched swivelled cross-lath

(when an opportunity to show the rear harmonic *alone* is afforded as the levers now ride on a common fixed axle in front), after which the single wave axle is easily inserted and the levers dropped down upon it by lowering the cross-lath.

Reference to the scheme of phases compiled in §10 shows that 16 generically distinct compound harmonics with an indefinite number of intermediate curves are obtainable. The variation is further enhanced by changing the component amplitudes by drawing out the levers. Among forms for equal amplitude the symmetric types are distinctive. They are obtained concave upward more or less *W*-shaped for components meeting at the origin both at maximum displacement ($+m$), and more or less *M*-shaped when both components meet at the origin at minimum displacement ($-m$). Similarly symmetrical forms are seen when the components at the origin are in opposite phases, viz., *V*-shaped when the front harmonic is at $+m$ and the rear harmonic at $-m$, and *A*-shaped when the front harmonic is at $-m$ and the rear at $+m$.

28. *Waves.* If these curves are to be transmitted in a compound wave which does not change its form each component must travel equally fast. Hence the rear axle with two wave-lengths must be rotated twice as fast as the front axle with one wave-length (pulleys 2 : 1). The periods are now also in the ratio of 1 : 2. Thus it appears, that it takes two rotations of the rear axle to exhibit the complete wave, or beginning with a symmetric type, for instance, the *W* and *A* curve together make a single harmonic curve; whereas the *M* and *V* curve make another, in relation to waves; etc., for non-symmetrical forms. The character of the wave is markedly progressive, each little kink as well as large elevations or depressions running along the axis in turn.

Referring again to the above table §10,

the present succession of phases is a march along a *diagonal* passing from left to right downward across the diagram.

29. *Case IX. with Component Velocities Unequal.*—If the component waves are transmitted unequally fast the compound wave continually changes form. Thus, if the 2 : 3 pulleys be used, it takes 3 turns of the rear axle to reproduce the original form; in 3 : 4 pulleys, four turns; in 1 : 1 pulleys, but a single turn. In the last instance the waves produced are much like stationary waves, with two nodes at the ends if the components meet at the origin in opposite phases, and one node in the middle if they meet in the same phase, phase difference being maintained constant at each cam. The table, §10, shows that the passage is now from left to right across the diagram, along a single row.

If one axle alone rotates a single turn again reproduces the original form, but the wave has now a progressive character, which is an inversion of the result in §28. In other words, the *W* and *V* types or the *M* and *A* types of curve are successive. In the table of phases, §10, the present succession for any single cam is given by a column passed from top to bottom.

30. *Case IX. with One Component Velocity Reversed.*—If the axles rotate with equal velocity in opposite directions the wave presents the succession of forms of the first (normal) case, but its character is now non-progressive, each particle retaining its peculiar form of vibration, which differs regularly from that of neighboring particles. But half the full wave is represented at once. No particle is permanently at rest and the stationary character is less pronounced than for the case in §29 with equal pulleys. Particles at the end of the curve in view are in like figures of vibration. In the above table, §10, the passage for any single pair of cams is now diagonally across the diagram, but from right to left, downward.

X. Components Simple Harmonics at Right Angles to Each Other, with Wave-Length Ratio, 1:2. Transverse Space Wave. 31. Harmonic Curves.—With the preceding cam axles, let the rear ends of the leaves be lifted upon the horizontal back plate and adjusted for the same component amplitude (Fig. 4).

Space waves of this and the following kind may be conveniently termed Lissajous waves, since their sunshine shadow on a screen normal to the axis of motion is always the appropriate Lissajous figure. Starting the waves with the initial eccentricities towards each other, the harmonic curve has a meandering space form, characterized, however, by its sunshine shadow, which is the specific bow-shaped 1:2 Lissajous, concave toward the cams. Dephasing the rear axle $+90^\circ$ produces the symmetrical 8-shaped figure; $+90^\circ$ farther the bow-shape again, this time, however, convex toward the axles of the cams; $+90^\circ$ farther returns the 8-shape described in a direction opposite to the preceding. The intermediate cases are asymmetrical 8's, but not well given unless the balls are small enough.

The harmonic curves themselves present no marked complexity. Seen from above they contain two wave-lengths; seen from the front but one wave, each in the appropriate phase at the origin. This gives a very clear analysis of the occurrences. The wave envelope in the bow-shaped cases is a gutter.

32. Waves.—The waves corresponding to the above space harmonics are instructive. If the figure of the compound wave is to be preserved, *i. e.*, if its shadow Lissajous is to remain fixed, both component waves must advance with rigorously the same velocity. This implies double rotation (double frequency) for the rear waves of shorter wave-length. The direction of rotation in the shadow is particularly well marked. For initially opposite or for like phases at the

origin the figure is alike 8-shaped, but when horizontal pointers on the front axle correspond to down on the rear or up on the rear the rotation is clockwise or counter-clockwise respectively in its upper half; etc.

33. Case X. with Component Velocities Unequal.—If the velocities of the component waves are unequal, but of the same sign (pulley 2:3, for instance), the compound wave continually changes form, as is best shown by the sunshine shadow. This is identical with the Lissajous curve for two tuning forks of the same amplitude, but with period ratios slightly different from 1:2. If the speeds of the two axles are equal (pulleys 1:1) a single rotation of the crank produces all the Lissajous between two occurrences of the same figure.

If the component periods are equal, but of opposite sign, stationary wave conditions appear for this case. Particles at the ends of the compound wave oscillate in any fixed Lissajous; the intermediate particle has the inverse figure. In general the permanent vibration figures vary proportionally to the distance apart of the particles. The sunshine figure is reproduced for $1/2$ rotation at the crank. One may note the contrast that, whereas the particles themselves vibrate in the elliptical Lissajous series, the sunshine shadow produces the 2:1 series.

If the component periods are unequal and opposite in sign the figures drift as above. The transitional case is given when but one axle rotates.

XI. Component S. H. Motions Coplanar with Wave-Length Ratio, 2:3. 34. Plane Harmonics and Waves.—The front cam axle is replaced by one containing 3 wave-lengths, with adjustments as above (Fig. 3). The curves of this series are more complex than the preceding, and if the dephasing be effected in steps of 90° each, 16 marked forms of curves may be exhibited. Among these the symmetrical types are

best adapted for recognition. They correspond respectively to like phases at the origin with maximum or minimum displacement of both components (*W*- and *M*-shaped forms), or to opposite phases at the origin with maximum and minimum, minimum and maximum displacements of the components (*V*- and *A*-shaped forms).

If the component waves are to advance with the same velocity the rear cam axle rotates twice while the fore axle rotates thrice, thus establishing a period ratio of 3:2. Hence each wave contains two of the specified harmonic curves in succession, or only one-half of it is seen at once. The progressive character of these waves as they dash along is singularly pronounced.

If the axles rotate equally fast in the same direction the wave assumes a stationary type, with one node at the middle of the component harmonics meeting at the origin in the same phase. If the latter meet at the origin in opposite phases, nodes occur at the two ends with marked vibration for intermediate parts of the compound wave. If the cam axles rotate equally fast, but in opposite directions, the compound wave shows 6 nodes if the components meet in opposite phases at the origin, and 5 nodes under other conditions.

Finally, if the wave velocities are equal, but opposite in sign, there is permanence in the vibration form of each particle, with difference of phase between them, but no nodes.

XII. *Component Simple Harmonics at Right Angles to Each Other, with Wave-Length Ratio 2:3.* 35. *Transverse Space Waves.*—The results are similar to the above cases, only more complex. The sunshine shadow on the normal screen shows the 2:3 Lissajous figure in permanent form if the axes are rotated at angular velocities of 3:2. The component waves are then transmitted with equal velocity and the period ratio becomes 2:3. If the component waves are transmitted with other velocities the compound wave

continually changes form, as does also the Lissajous shadow curve. The rotation within it is here again exhibited as to direction, etc., with remarkable clearness. To obtain steady results for this case the balls must be small and the ratio workmanship of the machine accurate, otherwise the incommensurable cases supervene. Experiments are made as above.

XIII. *Component Harmonics Circular and Vertically Simple Harmonic of any Wave-Length Ratio.* 36. *Harmonic Curves for Equal Component Wave-Lengths.*—The present curves are interesting, inasmuch as they present an intermediate stage between the above cases of S. H. composition and the next cases relating to the composition of circular motions. The wave machine is put into adjustment, as shown in Fig. 5, with cam axles and pulley ratios 1:1. The machine is tipped up in front.

Inasmuch as the S. H. M. of the front axle interferes with the vertical component of the circular motion of the rear axle, the phase difference is best specified in terms of these coplanar vibrations. For like phases, therefore, the Lissajous figure of the compound curve is a tall vertical ellipse, say 9" high and 3" broad. Advancing the front phase +90° inclines this ellipse to the rear, shrinking it throughout. Advancing the front axle +90° farther produces the simple harmonic curve in the horizontal with a double amplitude of 3". The further advance of the front phase of +90° expands the Lissajous figure into an oblique ellipse inclining to the front, etc.

37. *Waves.*—The rotation in the waves is always clockwise for a clockwise circular component. In this and other respects (pronounced prolateness combined with horizontal plane polarization) they differ from §20.

38. *Waves and Curves for Other Component Wave-Lengths.*—On replacing the front cam axle with one of one or three waves to the

two of the rear axle, peculiar apparently beknotted wave forms are obtained, well adapted to give a notion of the complexity resulting from simple compounding; but it is needless to refer to them further.

XIV. *Component Harmonics Both Circular, of any Wave-Length Ratio and Opposite in Direction.* 39. *Remarks on the Machine.*—

After the description of the machine and the remarks already made in the successive paragraphs above, it is not necessary to enter at length into a consideration of the present experiments. As to matters of adjustment in Fig. 6, I may note that the common horizontal locus of the centers of the approximate circles described by the free ends of the levers (they are really curves of the 6th degree), and the respective cam axles, must be equidistant from the perforated cross laths, *U* and *V*. In the given apparatus the effective lever length is about 18". In this case the lever ends describe curves which do not differ more than 1/8" from circular circumference, a departure not discernible with 1/2" balls. Nevertheless, the angular velocity in the quasi-circles is not uniform, a circumstance which from symmetry is without bearing on the vertical compound vibrations, but becomes more marked in proportion as the vibration is twisted around into the horizontal. The latter, therefore, appears somewhat convex downward unless very long levers are chosen. The adjustment in § 24, where the circles are nearly quite perfect, is thus in many respects to be preferred, though the levers are necessarily farther apart and the lever ends incapable of resisting much tension. There is inconvenience, however, in constructing special pairs of front and rear cam axles.

To find whether the circles at the lever ends have a common cylindric envelope the cam axles should be rotated in like direction. Coincident ends should then remain nearly coincident throughout. The

cross laths, *U* and *V*, are adjustable with this test in view.

40. *Rotary Polarization. Equal Component Wave-Lengths.*—Let the front cam axle be a left-handed, the rear axle a right-handed, screw (Fig. 6). Let them be equal in wave-length and amplitude. Then the component harmonics (loci of the lever ends or eyelets) will be respectively right and left circular helices, otherwise equal. The vibration lines of the particles, *W*, in Fig. 10, will all be coplanar, the plane being parallel to the cam axles at any angle to the horizontal depending on the phase difference of the initial cams. The compound harmonic, or longitudinal arrangement of the particles in the plane stated, is a simple harmonic, curve whose amplitude is the common diameter of the component circular harmonics.

This case has already been referred to in §24 and there exemplified. The compound curve, as constructed by the machine, is on a scale of one-half.

If the cam axles are rotated with the same velocity, opposite in direction (cross-belt), the corresponding plane-wave will result, unchanged in obliquity. One may note in passing that, whereas, in all the above compounding, plane-waves were obtainable in one or two special altitudes merely, they may now be obtained in all altitudes.

41. If the axles are rotated with unequal velocities, components of equal wave-length differ in period and velocity. The plane of the compound wave will, therefore, rotate about the axis of the component circles. Hence, if the oscillation of the first particle be put back into the same line after each oscillation (in general, continuously), *i. e.*, if oscillation is continually supplied at the origin in this line, the amount of rotation resulting will be proportional to the distances between particles. The rotary polarization so produced is due to a

difference both in the *period and the velocity* of the component circular waves of like wave-lengths.

42. *Unequal Component Wave-Lengths.*—With the front and rear cam axles still respectively left and right, if more turns be put on one than on the other, the harmonic curves will become helical. In other words, the compound of two plane simple harmonic curves of the same wave-length ratio and phase difference at the origin will now be inscribed on a regular helix. If the axles be rotated with the same angular velocity in opposite directions the component harmonics have the same period, but differ in velocity. The vibration lines in the compound wave remain fixed for each particle, but their directions differ in altitude proportionally to their distance apart. The rotary polarization so obtained is due to a difference in the *velocities* of the circular components. The helix may be rotated as a whole by dephasing the initial particles.

43. If the axles are turned with unequal velocities the helical compound wave must rotate as a whole about the common axis of the component circles, in consequence of the continuous and like dephasing at all cam pairs. Rotary polarization is again due both to difference of velocity and of period, as in § 41. If, however, the period of rotation at the cam axles is proportional to the wave-lengths of the helices the velocities of the components will be the same and the continuous rotation occurring due merely to difference in the periods of the components. Hence, if the oscillation in the first particle of the compound wave is always supplied parallel to a given line the rotary polarization obtained will be due simply to the difference in the *periods* of the components.

44. *Right-Handed Circular Component Harmonics.*—The same amount of rotation as in the last cases will be obtained when the wave-length of one of two equal right and

left cam axles is increased and that of the other decreased by half the stated increase of the single axle in § 42. It will even be obtained when both cam axles are right-handed screws or both left-handed screws, alike in all respects but differing in phase by 180° , subject as before to counter rotation (cross-belted). But, whereas the rotary polarization in the preceding case, § 42, is due solely to normal advance of the circular waves, it is now due to the independent counter rotations impressed by outside agency. The two right-hand helices specified, being opposite in phase, constitute a series of stresses in equilibrium and produce no displacement.

If the cam axles of equal wave-lengths rotate with the same velocity the compound wave is a helix, but with each of its particles in the same phase. The neutral position is thus a line of balls in the common axis encircled by the lever ends, and this may be used as a test on the adjustment. Each particle persists in its line of vibration, and their locus is a helix which expands and contracts in diameter rhythmically.

45. If the two axles rotate unequally swiftly the component circular waves advance unequally swiftly and the line of vibration of each particle or the contractile helix as a whole rotates around the common axis.

46. Finally, in two right-handed cam axles of equal amplitude, but different wave-length, the resultant harmonic curve will be the compound of corresponding plane harmonics, but inscribed on the corresponding helix. For rotations of the same angular velocity (equal periods) the helical wave will not rotate as a whole. For unequal periods it will so rotate.

Some of these cases are more important than others. Their application is a question of optics.

CARL BARUS.

BROWN UNIVERSITY,
PROVIDENCE, R. I.

THE WORK OF THE U. S. FISH COMMISSION.

THE report of the U. S. Commissioner of Fish and Fisheries for the year ending June 30, 1898, shows an increase in the propagation and distribution of food-fishes of about 40 per cent. over the work of any previous year.

The number of adult and yearling fishes, fry and eggs distributed in public and private waters or transferred to the State authorities was about 857,000,000, of which the largest number represented important commercial species, like the shad, cod, whitefish and salmon. There were thirty-three hatching stations and sub-stations in use, the steamer *Fish Hawk* being also utilized for shad-hatching in Albemarle Sound and the Delaware River.

The extension of the salmon-hatching work on the Pacific coast was especially gratifying, as the enormous annual drain on the salmon streams of that region makes it very important that the supply should be kept up by artificial means. At the sub-station situated on Battle Creek, a tributary of the Sacramento River, the largest collection of the salmon egg (48,000,000) in the history of fish-culture was made in the fall of 1897.

Particular attention was also paid to the hatching of young lobsters, owing to the steady decline in the lobster fishery, and as a result of these efforts no less than 95,000,000 fry were turned loose.

There is little doubt but that the future success of the lobster industry depends on the possibility of artificial propagation, and the same may be said of the salmon fisheries of the Pacific coast. What may be hoped for is shown in the steady increase of shad in the eastern United States.

In 1880 the catch was only about 18,000,000 pounds, and the catch steadily decreased until 1885, when the results of artificial propagation became observable. By 1888 the catch had doubled, and in 1896, the

last year for which there are accurate data, the catch amounted to 50,866,368 pounds, with a market value of \$1,656,711, the value of the increased catch for that year alone being something like \$800,000 in excess of the total cost of all shad propagation up to that date. Extended tables show the output of the different hatcheries and the details of the distribution of the eggs and fry of the various species.

The Division of Inquiry respecting food-fishes has made various investigations regarding the oyster, including a survey of the oyster grounds of Louisiana and a re-examination of the much-vexed question as to the origin of the color of green oysters. In regard to this the report states that in the United States it has been repeatedly demonstrated by the Commission that the green color is due to vegetable matter which serves as food, and that there is no impairment of the edible qualities of the oyster. The reason for the color of the 'red oysters' noted during the season of 1896-97 is unknown, as no opportunity was given to investigate the problem, but it is suggested that it may be due to the presence of the infusorian *Peridinium*.

In view of the scarcity of mackerel, which has extended over a longer period than ever before in the history of this fishery, special study has been given to the embryology, natural spawning and artificial propagation of this species. Its practical propagation is still an unsolved problem, and it is noted that under existing conditions the number of eggs obtainable is too small to produce any appreciable effect, while suggestions are given for enlisting the aid of the fishermen. The principal work of the Division of Statistics has consisted of canvasses of the more important fisheries of certain of the New England and Middle Atlantic States and of the Great Lakes, the information thus collected being made immediately available by the publication of

single-sheet bulletins. It is proposed to continue the issue of these from time to time whenever there is information of special interest. Attention is called to the fishery resources of the Yukon River, which so far have been utilized only by the Indians for their immediate needs, but which it is believed may afford a food supply to the miners and traders who have been attracted to that region, and ultimately to the country at large. Full statistics are given of the sections covered by the report, and it may be noted that at Gloucester and Boston there has been a falling-off in the aggregate receipts of fish since 1896, while the South Atlantic States as a whole show an increase in the product, the amount of capital invested and the number of persons employed in the fisheries.

What strikes one very forcibly in glancing over this report is the many discouragements the fish culturist is called upon to face and the large number of serious losses due to unavoidable, often seemingly trivial and sometimes inexplicable, accidents. A few degrees of temperature, more or less, a heavy shower, the lingering of ice or an unfavorable wind may cause heavy damage and almost bring to naught the labor of weeks. Another thought is to what extent should the general government undertake the propagation and distribution of the more strictly game fishes, such, for example, as black bass and trout? The investigation of the best methods for the accomplishment of such work should undeniably lie with the United States, but these once discovered, its continuance should rest with States and individuals. What may be done by individual effort is shown by the fact that a large number of the many ponds of Plymouth county, Mass., have been stocked with black bass by the simple process of carrying a few fish in pails from one pond to another. It may be said that the establishment of many of the trout hatcheries has

been due to the efforts of members of Congress and not to any desire of the Commissioner of Fisheries. The propagation of such widely-spread and all-important species as cod, shad, the Pacific salmon and the lobster is quite another matter and should properly be carried on by the United States.

The statistical as well as the strictly scientific work of the Fish Commission is again of national importance, and the special omission of fishery statistics from the coming census bears testimony to the value of the work done by this division.

It is gratifying to learn that the appropriation for scientific work has this year been materially increased, for, from past experience, we know that what to-day appears to be a purely scientific problem to-morrow becomes an all-important practical matter. In this connection Dr. Smith urges the appointment of an expert in fish pathology, calling attention to the large mortality which often prevails among fish, both under natural and artificial conditions, and for which there is at present no known cause or remedy. The annual losses at the hatcheries of the Commission, while not excessive, are still great enough to demonstrate the need of skilled investigation, and the present expenditure of a few thousand dollars may yield subsequent returns of millions.

Last, but not least, it may be again noted that under the present Commissioner it has been arranged to keep the laboratory at Wood's Hole under the scientific direction of Professor Bumpus open throughout the year.

ENGINEERING AND THE PROFESSIONS IN EDUCATION.

THE receipt of the annual volume of Proceedings of the 'Society for the Promotion of Engineering Education'* is a reminder of

* Proceedings of the Sixth Annual Meeting of the Society for the Promotion of Engineering Education, Vol. VI. Published by the Society. 1898. 8vo. Pp. xxvii + 324.

the extent to which all departments of education are becoming systematized and organized in the United States. Hitherto, in all countries, there had been observable a very serious lack in this respect, even in Germany, where the central government, and the authorities of every kingdom alike, control and direct the education of all classes from central organized bureaux.

With us primary and secondary education have had consistent and authoritative direction, not always wise or expert, but always earnest and well-intended; for the common school has been recognized, from the first, as the strongest bulwark of our institutions, political and social. Professional education and training, however, have, like all higher learning, been sustained mainly by private, sporadic and unsystematic, unauthoritative, support and aid. Education, in a true sense and on the lower levels, has been fairly well-cared for; professional training, that education which is rather a noble form of apprenticeship to a noble vocation, finds even yet almost no public and little private recognition. Of late the schools of engineering are securing some attention from investors in this form of higher security and from the State Legislatures and expert educators and professionals. In the West, particularly, the schools of the vocations are attracting more and more attention as their relation to and bearing upon the social condition of the people is coming to be generally appreciated.

The volume before us contains the proceedings of a single meeting of a representative association of this class, and presents a very excellent picture of the purposes and methods of such an institution. The Society, about five years old, numbers 244, and includes practically all of the leaders in the development of this branch of technical educational work in the country, and representatives from nearly all recognized

professional schools in this field. Twenty-nine papers are published, together with lists of officers and members, the constitution of the Society, its rules and its proceedings at the Boston meeting of 1898.

The leading paper is the address of President Johnson, a discussion of the topic: 'A Higher Industrial and Commercial Education as an Essential Condition of our Future Material Prosperity.' This is a most interesting and impressive statement of the needs of the United States in this direction, and of the dangers that threaten a nation neglecting to systematize its industrial system and the education of the 'Industrial Classes' for their life and work in presence of a competition which is coming to be more constant and more dangerous as the means of communication and of transportation become more extended and more perfect. The foreign 'Mono-technic Schools' are held up to our view as models of a type of school which is almost unknown in this country, and as having proved the salvation of the Germanic peoples. The establishment of high-grade mono-technic and commercial schools is urged as the most promising and desirable of all visible modern improvements in education and training for the industrial classes.

A full evening was given to a paper 'On the Organization of Engineering Courses and on Entrance Requirements for Professional Schools,' in which the writer, following a somewhat similar line of thought, developed the theory of professional education, exhibited the logical differences between the real 'education' of the academic colleges and the primarily vocational training, the 'higher apprenticeship' of the professional schools; showing that while the one should offer a 'ladder from the gutter to the university,' as Huxley said, the other lets down a ladder from the profession to the people, the two thus demanding radically different methods of construction of

their curricula, as well as different methods of prescription of entrance requirements. The one supplements the schools, and must build smoothly up from below; the other builds down from the profession, and must, at all hazards, make its junction at the upper end effective, while its entrance requirements must be such as will least embarrass the aspirant while satisfying the proper demands of the profession. Each curriculum, however, must be constructed by experts in its own field, and the professional must be relied upon to perfect the courses and prescribe the requirements of the technical school, as must the expert in academic education be expected to be given a free hand in the upbuilding of general education.

Shorter papers on laboratory work, on details of educational apparatus, 'thesis work,' courses of instruction in various departments and reports of committees, fill the volume with a mass of material hitherto unparalleled in this line, and which must deeply interest, not only workers in this field, but all educators, and particularly all who are interested in the promotion and improvement of our still defective and inadequate educational provision for the best interests of the industrial classes, and in the advancement to still higher planes of our professional schools. The careful study, not of this volume only, but of the series, beginning with the organization of the Association at the Educational Congress at Chicago, in 1893, in connection with the Columbian Exhibition, cannot but well reward every one interested in the modern and current movements in this politically, as well as socially, important department of the scheme of national education, the perfection of which is so vital an element in determining what shall be the political and the moral and intellectual status of our country in coming generations.

R. H. THURSTON.

SCIENTIFIC BOOKS.

Die chemische Energie der lebenden Zellen. DR. OSCAR LOEW. Munich, Dr. E. Wolff, publisher. 1899. Pp. 170.

This publication gives the results of a series of observations on the chemical characteristics of living matter. It is proved that the proteids of living matter are of very labile nature and different from those of the dead matter, into which they are transformed by atomic migrations in the molecules. It is also demonstrated that in many plants a labile reserve-protein occurs which is not yet organized, but is changed by the same conditions as kill the cells. The book contains the following chapters:

1. Views on the causes of the vital activity.
2. General characteristics of living matter.
3. Chemo-physiological characteristics of living matter.
4. The essential concomitants of protoplasm.
5. The character of the biochemical work.
6. On the formation of protein in the lower fungi.
7. On the formation of protein in the green plants.
8. Theory of protein formation.
9. A labile protein as reserve material in plants.
10. Chemical characteristics of the labile proto-protein.
11. Lability and activity in the protoplasm.
12. Theory of respiration. Chapters 9 and 10 give the results obtained in conjunction with Th. Bokorny.

The most modern progress of theoretical chemistry has been brought to bear in this work. The theories advanced in the work and the suggestions which they contain will make the book invaluable to students of bio-chemistry and physiology. Doctor Loew has concluded his work with the following brief summary:

"It may be briefly recapitulated in a few words how much the theses put forth correspond or coincide with the observations made. In the first place, it should be remembered that the living substance shows a great resemblance to a chemically labile body and that the dying process of the protoplasm is suggestive of the transition of a labile into a stable modification of organic compounds. According to the theory developed in the eighth chapter concerning the formation of albumin, the lability of the plasma-protein is due to the simultaneous presence of aldehyde and amido groups. The

toxicological facts reported in the eleventh chapter, indeed, support this view.

The further inference from the theory, that very labile but not yet organized protein substances possibly occur in plants, has also been verified. An exceeding labile reserve protein of an aldehyde nature was proved by Bokorny and myself to exist in many kinds of plants; its characteristics are described in the ninth and tenth chapters.

Labile substances contain kinetic chemical energy; they contain certain loosely bound atoms, which under the influence of heat become more mobile than in case of a more stable arrangement. As a result chemical reactions are caused, the energy of these atoms being transferred to certain susceptible substances (sugar, fatty acids), which are thus drawn into a state of higher reactive power, especially with the otherwise indifferent oxygen of the atmosphere. In other words, catalytic actions are produced through a charge with chemical energy. The proteins of living substances appear as relatively firm structures in which separate labile atoms perform great oscillations. This conception is essentially different from that of Pflüger and Detmer, both of whom ascribe to all atoms in the plasma-proteins such an intense state of motion that a dissociation results, to be followed by a similarly energetic regeneration. Pflüger says: * "I do not expect to meet with any opposition if I consider the living matter as not only being astonishingly changeable, but steadily decomposing."

Yet, when we consider that a minimal attack of extremely small quantities of a poison will produce the death of a cell, one may well doubt whether such a metabolism as Pflüger assumes would not sooner lead to death than to a possibility of regeneration. Neither can we, therefore, agree with Verworn when he says: † "The life process is the sum-total of all processes connected with the building-up and destruction of the 'biogens,' or, 'life consists in the metabolism of the albuminous bodies.'" A more correct definition would be the following: Life is the sum-total of the effects made possible by the labile nature of the plasma-proteins and

their respiratory activity, and governed by the specific tectonic of the energides and of the active paraplasmic structures.*

The nature of the living matter is in the first place determined by lability and organization, that is, by a systematic kind of motion in a structure (tectonic) of labile proteins. The principle of organization is not yet known. Even if we assume with Pflüger that the process of organization consists merely in a polymerization, the complicated details in generation and karyokinesis, would still defy explanation, and the genetic differentiation would not become better intelligible. Difficult problems are here facing us. Still it may be considered a slight advance to know at least a little more about the cause of respiration and the chemical energy of the cells than formerly. It is the lability of the plasma-proteins, which, supported by the effects of light, leads to the building-up of the carbohydrates in the green plants out of carbon dioxide and water with separation of oxygen. It is also this lability which assists in combining the organic substances with oxygen and renders the obtained energy applicable to physiological work.

In addition to the well-known fact that all life functions are based upon the energies of the sun, it must be inferred that the lability of the plasma-proteins is necessary to transform this sun energy into vital action.

ALBERT F. WOODS.

DIVISION OF VEGETABLE PHYSIOLOGY AND PATHOLOGY, U. S. DEPARTMENT OF AGRICULTURE.

Physical Geography. By WILLIAM MORRIS DAVIS, assisted by WILLIAM HENRY SNYDER. Boston, Ginn & Company. 1898. Pp. 431.

Professor Davis well states in his preface the central principle of this volume: "Physiographic facts should be traced back to their causes and forward to their consequences." We find thus the widest departure from the piecemeal description and recital of facts, of most works in physical geography. We should expect this from one who has long been eminent as a student and teacher of the science and who

* Kupffer designates the contractile substance of the muscular fibrille, the nervous fibre and the red blood corpuscles as 'paraplasmic' formations.

* Pflüger's Archiv 10, p. 311.

† Allgemeine Physiologie, 2d edition, p. 509.

has not ceased to magnify the causal notion and the consequent educational value of geography. It cannot hereafter be said that the materials of the new geography are not available to the rank and file of teachers, as was conceded in the report of the Committee of Ten. The limits of a secondary text-book forbid anything like a full discussion, and it is to be hoped that a manual or college text-book may come from the author's hand. He has discarded, for the most part, technical terms. Thus the doctrine of the peneplain is elucidated in the text, but the name appears only once, and that in a footnote. The rational geography makes large use of geology, but this has been done in a simple fashion which obviates the necessity of a previous course in that subject for the pupil, though the teacher would find such knowledge all but indispensable. To dwell for a moment longer on the pedagogical aspects of the volume, the vital teacher need not hesitate to use it, though he be deficient in preparation, but it is emphatically a book for the best, and only such can wholly do it justice. It wisely joins itself to the present state of knowledge, but leads well out among the ideals and possibilities of the science.

The illustrations are profuse and well selected. Especially useful are many diagrams which combine surface relief and vertical section, thus relating geographic form and geological structure. The appendix contains valuable bibliographic lists and a short catalogue of the best maps, whose use and importance are everywhere emphasized.

The Earth as a Globe, the Atmosphere, the Ocean and the Lands are the four main subdivisions of the book. All but the last are briefly treated, offering an outline of the chief facts in mathematical geography, meteorology and oceanography, terms which we think, for the present purpose, wisely discarded.

The lands are treated with greater fullness, the discussion occupying 273 pages. The chapter headings will best show the general character of this section. They are: The Lands, Plains and Plateaus, Mountains, Volcanoes, Rivers and Valleys, The Waste of the Land, Climatic Control of Land Forms, and Shorelines. The origin of these forms and their con-

sequences upon organic and especially human life are never lost from view, and thus is realized the highest definition of geography as a study of the 'physical environment of man.' No separate sections are devoted to the races of man or the distribution of animals, but a reader of the whole volume will discover that these subjects have not been neglected, but have been treated in an intimate and educational fashion.

The principle of change of form by erosion and by change of relation to sea-level is early stated and receives manifold elucidation to the end. The Plain offers a good example of the author's method. We have first the formation of a coastal plain by deposition of land waste and uplift of marginal sea-bottom, with subsequent dissection by land streams. There logically follows the broader, higher, older and more dissected coastal plain, the eastern Carolinas serving as an example. The favorable conditions for artesian wells form here a naturally related topic. Embayed coastal plains show the effect of the later, partial submergence, the Chesapeake being used as a type. Such use of physiographic types, as a means of seeking and classifying examples in all parts of the world, is a favorite and important principle with our author. Similar plains of very ancient origin, as in central-southern Wisconsin and western New York, are then described and connected with the younger, less modified types, but without involving the difficult ideas or nomenclature of historical geology.

The plateau, or uplifted plain, appropriately follows. Thus we have young plateaus, as in Arizona; mature and well-dissected plateaus, as in the Catskill-Allegheny-Cumberland belt, and old plateaus, as recognized in the buttes, mesas and table-topped mountains of the West.

The treatment of mountains is, for the space, equally thorough and interesting. The various kinds are described—block mountains in various stages of maturity; folded and domed mountains, with such fruitful subtopics as climate of mountains, mountains as barriers, valleys among mountains, and inhabitants of lofty mountains.

The chapter on Rivers and Valleys well illustrates the strides of physiographic science dur-

ing the last score of years, as will appear from an outline of the chief topics. Thus we have young rivers, with lakes, falls and rapids as marks of immaturity; graded rivers and the development of valleys; meanders and the shifting of divides; mature and old rivers; revived, antecedent, engrafted and dismembered rivers, the causal or historical notion appearing at every stage of the discussion.

The general reader who desires to cultivate an appreciation for natural scenery will find help in Professor Davis's volume, and the student to whom most of the materials are familiar will find a convenient and systematic summary of the important facts and doctrines of a great and growing science.

ALBERT PERRY BRIGHAM.

COLGATE UNIVERSITY, February, 1899.

GENERAL.

The Bulletin of the American Mathematical Society states that advices from the Vatican announce that Abbé Cozza Luzzi, assistant librarian, has found Galileo's original manuscript treatise on the tides. The manuscript is in Galileo's handwriting and concludes with the words: 'Written in Rome in the Medici Gardens on January 8, 1616.' The currently accepted text, the original of which was supposed to have been lost, differs considerably from that of the manuscript just found. Pope Leo XIII. has taken the greatest interest in the discovery and has ordered the manuscript to be published in an elegant edition at the expense of the Vatican.

THE London *Times* announces that it will prepare a supplementary volume to the ninth edition of the *Encyclopædia Britannica*. This edition was published between 1875 and 1889. It is well known that the treatment of scientific subjects are in many cases the best accessible to English students, being prepared by leading English men of science. It is unfortunate that a new edition of the *Encyclopædia* cannot be prepared, as the last twenty-five years have brought many changes in all the sciences, but a supplementary volume will be of some service.

BOOKS RECEIVED.

A Handbook of Medical Climatology. S. EDWIN SOLLY. Philadelphia and New York. 1897. Pp. xii + 470.

Minerals in Rock Sections. LEA MCILVAINE LUQUER. New York, D. Van Nostrand Co. Pp. vii + 117.

Die Medial-Fernrohre. L. SCHUPMANN. Leipzig, Tuebner. 1899. Pp. iv + 145. Mark 4.80.

Die Lehre vom Organismus und ihre Beziehung zur Sozialwissenschaft. OSCAR HERTWIG. Jena, Fischer. 1899. Pp. 36. Mark 1.

Regeneration und Entwicklung. H. STRASSER. Jena, Fischer. 1899. Pp. 29. Mark 1.

Elementary Physiology. BENJAMIN MOORE. New York, London and Bombay, Longmans, Green & Co. 1899. Pp. ii + 295.

Primer of Geometry. JAMES SUTHERLAND. London, New York and Bombay. 1898. Pp. 117.

SOCIETIES AND ACADEMIES.

THE GEOLOGICAL CLUB OF THE UNIVERSITY OF MINNESOTA.

At a meeting of the Club on February 25th Professor C. W. Hall discussed the extent and distribution of the Archean in Minnesota. First, accepting the Archean as that original 'crust,' or solidified portion of the earth, which is postulated in every existing view of the beginning of the geological record, he defined it as an era of igneous origins whose rocks represent the original crystallization of earth matter added to from below by successive solidification and many subsequent intrusions. By this definition all overlying clastics or irruptions into or through the clastics are excluded from the Archean. If the base of the clastics can be found there certainly should be found, locally, at least, the rocks upon which they lie. Such underlying rocks, the Archean, are believed to occur in Minnesota in two quite separated districts, the northern and the southwestern.

Along the international boundary most geologists have grouped all the rocks from Basswood Lake to Lake of the Woods as Archean, even when clastics have been clearly recognized and eruptives found breaking through them. Lack of care in delimiting the Archean upwards has caused much confusion. Lawson set an example in distinguishing between clastics, 'agglomerate schists' and the rocks underlying, though not necessarily those from which the clastics are derived. Structurally the

Archean of the Lake of the Woods forms a series of troughs—four is the number given—in which the Keewatin schists now lie. [Compare Geol. and Nat. Hist. Sur., Canada, N. Ser., Vol. I., 1885, C. C., pp. 10 et seq.] Although there are no sharp unconformities to be seen, yet, as Lawson observes, "the fact that we find in the Keewatin series the first undoubted evidences for this region of aqueous sedimentation and also of volcanic action, while in the underlying Laurentian gneiss of the region we find evidence of neither, more than suggests that the Keewatin series had a totally different kind of origin from that of the gneisses and must, therefore, be in unconformable relation to them" [Ibid., p. 84].

At Rainy Lake H. V. Winchell and Grant found a series of granites and granite gneisses beneath the other rocks (i. e., Archean) and eruptive into them. Since these authors did not think best to distinguish between underlying and eruptive granite rocks their work is of but little taxonomic value. [Geol. and Nat. Hist. Surv., Minn., 23d An. Rep., 1895, p. 58.]

Between Rainy Lake and Lake Superior there are several belts of schists with alternating granites and other rocks having a general northeast-and-southwest trend. Concerning one of these, Irving noted in 1886 "that we have among the rocks * * * two types, in one of which the crystalline structure is complete and in which there is little or none of an original fragmental structure, while in the other the fragmental texture is still distinct and the alteration has progressed to a smaller degree." He then adds "that the supposed older one of the two groups of schists in the Vermilion Lake belt is intricately penetrated by the granites of the great areas north and south of the belt." [7th An. Rep. Director U. S. Geol. Sur., 1885-86, p. 437.] Hence areas of Archean lie north and south of these older schists.

In the Minnesota River Valley lies the most carefully studied series of granite gneisses, gneisses and gabbro schists of the State. These rocks occur quite continuously from New Ulm to Ortonville and beneath the glacial drift stretch westward into South Dakota and disappear beneath the Dakota sandstone. At New

Ulm they clearly underlie a quartzite conglomerate regarded as Huronian (whether lower or upper is not determined). This Archean series is divided, for purposes of study, into a lower and upper; the former is named the Ortonville group of augite, hornblende and biotite granite-gneisses, and the latter the Granite Falls group of hornblende and biotite gneisses and associated gabbro schists. [Hall, Syllabus of Geology, 1897, p. 83.]

F. W. SARDESON,
Secretary.

THE BOTANICAL CLUB OF THE UNIVERSITY OF CHICAGO.

At a recent meeting of the Club, Dr. Otis W. Caldwell gave the results of his study of *Lemna minor*. The following is an abstract of his paper: Owing to the greatly reduced body of the sporophyte of the Lemnaceæ there has been much interest in its morphology, and in the question as to the effect of the reduction upon the gametophyte. The investigations show that the sporophyte body is neither stem nor leaf, as often contended, but a shoot undifferentiated except at the basal or foot region and at the nodal region from which the root, the new shoots and the flowers arise. The root originates from a small group of hypodermal cells on the lower side of the node. The epidermis develops a temporary root sheath, while the persistent root cap is developed from the meristem, which is never many-celled and in a few cases was seen to be unicellular. Flowers are rarely formed, and frequently when they have begun to develop they are crowded out by vegetative buds which are produced in great abundance. Even when not encroached upon by vegetative shoots the flowers do not often succeed in forming seeds. The pollen grains usually become fully formed, but the structures of the ovule and embryo-sac may disorganize at any stage in their growth. Although the chief stages in ordinary embryo-sac development were found, such were shown by very few preparations; while in most of the preparations embryo-sacs were disorganizing, the disorganization first affecting the antipodals, then the polar nuclei or primary endosperm nucleus, the egg being the last to succumb to the unfavor-

able conditions. Cases were observed in which the upper polar nucleus, failing to fuse with the lower one, had proceeded unassisted to the production of endosperm. Few embryos were found.

In the young stamen but one archesporial mass appears. After this has enlarged somewhat a plate of sterilized tissue divides it into two regions, each of which is again divided in a similar manner, thus constituting the four archesporial masses of the anther. The four loculi of the anther are four parts of one sporangium, and not four sporangia, as reported usually for other spermatophytes. The primary tapetal layer is not differentiated until after the archesporium is separated into four masses. The tapetum may be derived either from the sporogenous tissue or from the adjacent sterile tissue. The cells of the tapetum frequently divide and push out into the cavity of the loculus, where they assist in nourishing the spore mother cells. Some of the latter are nourished also by other mother cells whose growth has ceased. The microspore germinates while within the sporangium. The generative cell remains closely applied to the wall of the spore for a considerable time before dividing to produce the male gametes.

The 'winter buds' seem to be summer buds which are not sufficiently vigorous to develop the necessary air spaces to keep them afloat. When conditions become favorable growth is renewed, air spaces develop in abundance, and the buds rise again to the surface.

It seems clear that *Lemna minor* has descended from terrestrial forms. The entire body of the diminutive plant, as evidenced by the disappearing root, the system for aeration, and the devices properly to relate the chloroplastids to the light, indicates attempts toward adaptation to the water habitat. It has not succeeded in working out such appropriate devices for pollination as are found in most water plants. The water environment also seems especially injurious to the embryo-sac structures of this plant, and the ease with which vegetative buds are produced, and the fact that some of these buds may serve to perpetuate the plant from year to year, reduces the necessity of seed production.

ENTOMOLOGICAL SOCIETY OF WASHINGTON.

UNDER the head of 'Short Notes and Exhibition of Specimens,' Mr. Benton stated that on January 22d he had found brood honey bees in all stages of growth and new adults, indicating egg laying the last of December. This is a very early instance.

Mr. Matthis exhibited specimens of what he takes to be *Boreus brumalis* Fitch, which he had caught upon the snow in the Rock Creek Valley after the recent blizzard. He showed for comparison specimens of a *Boreus* which he had caught last October at a high elevation on the Big Horn Mountains. This was a larger and darker form than *B. brumalis* and has not been specifically identified.

Dr. Dyar showed a blown larva of *Apatela clarescens* Gn., previously undescribed. The larva nearly resembles that of *A. hamamelis*; indeed, from the mature larva alone no constant differences can be pointed out, but Dr. Dyar has observed certain differences in the earlier stages of these larvæ, which will be more fully worked out at the next opportunity. In this connection, he also presented a list of *Apatela* by Professor A. R. Grote, with generic and subgeneric types, which had been prepared by Professor Grote on request, and which is supplemental to the monograph of the genus recently published by Smith and Dyar. Dr. Dyar stated that he was pleased with Professor Grote's erection of a subgenus for *A. funeralis*, since this was definable on larval character, as are all the other subgenera of *Apatela*, except *Tricholonche* as compared with *Lepitoreauma*.

Mr. Schwarz exhibited some very dry and hard pulp of the giant cactus, taken by Mr. Hubbard in the autumn of 1897 and containing specimens of the extraordinary Scolytid, *Cactopinus hubbardi* Schwarz. He had examined this pulp in January, 1897, and found the beetles alive, with no indication of oviposition. He moistened it somewhat at that time and showed the same beetles still alive, thus indicating that they may live in the adult condition for two years.

Mr. Howard showed a remarkably clear and beautiful photograph of *Phasgonophora sulcata* Westwood, which had been taken by Mr. M. V. Slingerland, and spoke briefly of the ad-

vantage of photography in entomological illustration, expressing the opinion that a fair photograph reproduced by the half-tone process is in many instances better than a poor drawing, but that the best photographs he had seen reproduced in this way were by no means equal to drawings made by competent artists. Such a photograph as the one exhibited, however, marks a great advance on previous efforts of the kind and would be invaluable at least as an aid to the artist, and if transferred by photography to a wood block and then handled by a competent wood engraver would obviate all necessity for drawing and would produce the most satisfactory results which could be obtained, since the slight failures in details could be easily rectified by the engraver.

Dr. Gill mentioned the resemblance of certain coleopterous larvæ to certain Trilobites, especially among the Staphylinidæ. He said he had been struck by this resemblance in a figure of a *Silpha* larva, even the antennæ resembling the antennæ of Trilobites as recently discovered by Beecher. He mentioned the figure of *Fluvicola*, an Isopod crustacean, in De Kay's volume on the 'Crustacea of New York, and Le Conte's conclusion that it was the larva of *Psephenus*, and asked for further information as to this resemblance.

Mr. Schwarz said that this wonderful resemblance extends through several families of Coleoptera. He instanced *Micropeplus* among the Staphylinidæ, a genus of Scydmanidæ figured by Meinert, various genera of Endomychidæ, groups of species in the old genus *Silpha* *Psephenus* and *Helichus* among the Elmidae, and various genera of the Dasyllidæ and Lampyridæ. The resemblance is largely caused by the exfoliation of the sides of the body. What its function is he did not know, some of the larvæ possessing it being aquatic, some sub-aquatic and some terrestrial.

The first paper of the evening, by Dr. Dyar, was entitled 'On the Fluctuations of the Post-spiracular Tubercle in Noctuid Larvæ.'

The second paper included a continuation of Mr. Hubbard's letters from the Southwest, presented with notes and comments by Mr. Schwarz. The letters read at this time related to the Colorado Desert and to Salton Lake and

its insect fauna. Some discussion ensued on the question as to whether the Colorado Desert has been occupied at any modern period by an arm of the sea, Messrs. Vaughan, Schwarz and Gill taking part.

L. O. HOWARD,
Secretary.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

At the meeting of the Academy of Science of St. Louis of March 6, 1899, Professor J. H. Kinealy described some experiments on lifting water by means of compressed air, as is done by the Pohle air-lift pump, and discussed the efficiency problems of the use of apparatus of this description. Three persons were elected to active membership.

WILLIAM TRELEASE,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

THE IMPORTANCE OF ESTABLISHING SPECIFIC PLACE-MODES.

TO THE EDITOR OF SCIENCE—*Sir*: I use the word 'place-mode' to embody a well-known idea, namely, that a species has a different mode (*i. e.*, a different prevailing condition of size, color, etc.) in different localities. The person who seeks to determine a place-mode determines the prevailing dimension of the principal measurable qualities (and practically all qualities of organisms are measurable) of a species as it occurs in the locality in question.

The importance of this work is as follows: It fixes the condition of a species in a particular locality at a particular time; it affords a base from which we may measure any change which the species has undergone in the same locality after a certain number of years. That species in nature do undergo changes within a man's lifetime is recognized by some conchologists who find that certain shells of the seashore have undergone within a half century an evident change of index (ratio of length to breadth). A case of especial interest because of the exact measurements which have been made is that of the rock crab of Plymouth, England, the frontal breadth of whose carapace has diminished year by year at a measurable rate (1 to 2 per cent. in five years), a result explained by certain

changes in the physiography of the region (Weldon). Such facts indicate that species are changing in essential specific characters and sometimes rather rapidly changing. The changes are not sufficient to be detected in cases where the descriptions are wholly qualitative or based upon the observation of a few individuals. But where a large number of individuals, taken at random, are measured the modes may be used as standards for reference. With the aid of such standards we can observe not only the fact of change, but the rate and the direction, and draw conclusions concerning the causes of specific change. If two modes occur in a species in one locality we can determine whether they separate farther and farther from each other, and the rate of such separation. A careful correlation of the facts of separation of modes with changes in environment will give us an insight into the causes of specific differentiation. In a word, the establishment of these place-modes for various species in various localities is the first sure step toward the solution of the problem of the Origin of Species.

The methods of this work are very simple. They involve the measurement of size, of proportions and other elements of form, and of color, by the color wheel;* they involve also counting repeated organs. The measurements, or counts, are to be grouped into classes on the basis of size. The means of measurement will naturally be found; but, most important of all, far more significant than the mean, is the *mode* or the *most frequented class*. The mode gives the typical condition of the lot of individuals measured.

The end of the old century or the beginning of the new one is a convenient time for making a number of these determinations, and it is on this account that I write to suggest to field naturalists that for a year or two they bend their efforts to the determination of place-modes. I am so convinced of the importance of this work that I am planning, with the cooperation

* The color wheel is an instrument for determining the percentage of constituent elementary colors in any compound color. A small, cheap and convenient form of this instrument—called the color top—with standard colors may be bought for six cents of The Milton Bradley Company, Springfield, Mass.

of students, to work on this subject at the laboratory at Cold Spring Harbor during the coming summer, and I hope that simultaneous co-operative observations may be made at Woods Holl and other marine laboratories as well as at the various inland stations and by private collectors elsewhere. There is no fear of duplication of work, for two persons will hardly study the same species in one and the same locality.

CHAS. B. DAVENPORT.

HARVARD UNIVERSITY, March 2, 1899.

IDENTITY OF COMMON AND LABRADOR WHITE-FISH.

THE Common Whitefish of the Great Lakes was first very imperfectly described by Dr. Samuel L. Mitchill, in *The American Monthly Magazine and Critical Review* for March, 1818. The description, in fact, is so unsatisfactory that his contemporaries and later ichthyologists for more than fifty years supposed it to refer to the Cisco, or Lake Herring, *Argyrosomus arctedi*. A good account of the Whitefish was published by Richardson in 1836, under LeSueur's name of *Coregonus albus*, a name published only a few weeks later than that of Mitchill; but, like Mitchill's, unaccompanied by a sufficient description.

In 1836 Richardson established a new species of *Coregonus* upon a dried specimen which he received from Musquaw River, that falls into the Gulf of St. Lawrence, near the Mingan Islands, giving it the name *Salmo* (*Coregonus*) *labradoricus*. This has been retained in the literature as a distinct species up to the present time, although its close relationship to the Common Whitefish has sometimes been observed without recorded comment.

Systematic ichthyologists have found it difficult to show clearly the differences between the Common Whitefish and the Labrador Whitefish, as may be seen by referring to the monographs upon the Whitefishes by Jordan and Gilbert, Bean, and Evermann and Smith. They have been forced to rely, finally, upon a single character, the presence of several rows of teeth on the tongue to distinguish the two forms, and this was supposed to be constant and infallible.

The writer has recently had occasion, while

studying the fishes of the State of New York, to examine numerous specimens of the Common Whitefish from the Great Lakes and interior lakes of New York and of the so-called Labrador Whitefish from lakes of New York and New Hampshire and from rivers in New Brunswick and Labrador. As a result of these investigations he is forced to the conclusion that Richardson's species, *Coregonus labradoricus*, is identical with the Common Whitefish, *Coregonus clupeiformis*, there being no characters by which the two can be distinguished. Every individual of the Common Whitefish, young and old, was found to have teeth on the tongue and to possess the other characters by which Richardson's species has hitherto been separated.

This conclusion has an important bearing upon fish cultural operations by the States and the United States, as it will tend to simplify the work of artificial propagation and, perhaps, extend its scope.

TARLETON H. BEAN.

WASHINGTON, D. C., March 3, 1899.

A DATE-PALM SCALE INSECT.

DR. A. S. PACKARD writes from Biskra, Algeria, January 23, 1899: "I find myself in this oasis of the northern edge of the Sahara, where there are 170,000 date palms. In a beautiful garden I found a date palm, indeed several, affected by Coccids, which I enclose." The Coccids are crowded on the pieces of leaf and prove to be *Aonidia blanchardi*, Targioni-Tozzetti, Mém. Soc. Zool. France, 1892, Vol. V., p. 69. The insect, however, is not an *Aonidia*, but belongs to *Parlatoria*, and must be called *Parlatoria blanchardi*. It was originally found in the oasis of Ourir, and has never, I believe, been noticed since its original description until now rediscovered by Dr. Packard.* The figures of Targioni-Tozzetti represent it well, except that in one of them (Fig. 3) there is an impossible lobule between the median interlobular squames. The female turns bright olive green on being boiled in caustic soda. There are four small groups of circumgenital glands. This insect is likely to

* Unless Maskell's *P. proteus* var. *Palmæ*, found in Australia on date palms imported from Algeria, is the same, as indeed seems likely.

be of some economic importance, as it is allied to, though easily distinguished from, *Parlatoria vitrix*, Ckll.; which, introduced from Egypt, has proved a pest on date palms in Arizona, California and Queensland. The manner of the infestation is quite the same in the two species.

T. D. A. COCKERELL.

MESILLA PARK, N. M., February 16, 1899.

THE CHOICE OF ELEMENTS.

TO THE EDITOR OF SCIENCE: Once upon a time, according, I believe, to Messrs. Gilbert and Sullivan, a magnet hanging in a shop window fell in love with a silver churn, but, to its great distress, was unable to awaken any response. Its pathetic plaint ran:

"If I can wheedle
A nail or a needle
Why not a silver churn."

I used to think the magnet very unreasonable, because I supposed the atoms of iron and steel were necessarily drawn to it willy nilly, while there was no such tendency in the silver atoms, which were consequently quite unable to respond to its call. Major Powell (SCIENCE, February 17th) puts the matter in a new light, which awakens my sympathy for the magnet. It appears that the particles have choice. Both common sense and the dictionary tell us that choice is the power of choosing. Thus it was not of necessity, but of their free will, that the nails and needles were so responsive. The silver churn evidently considered the magnet ineligible. The case of the latter is a truly sad one, worthy of all serious commiseration, for if, as Major Powell tells us, the particles have intelligence, why should they not have love also? True, the magnet as a whole does not know, but what can assuage the grief of each of its myriad particles? Is there any hope that in time the silver will think better of it?

T. D.

HARVARD MEDICAL SCHOOL, February 27th.

ASTRONOMICAL NOTES.

TUTTLE'S COMET.

THIS comet was discovered by Méchain at Paris in 1790. Only a few observations were

taken, however, and the comet was rediscovered by Horace P. Tuttle at the Harvard College Observatory, January 4, 1858.

Johannes Rahts, of Königsberg, made the most complete discussion of the orbit, combining the observations of 1858 and 1871-2, having regard also to the perturbations. His value of the period is 13.7 yrs. The comet was next seen in 1885, and was expected during the present year. An ephemeris was accordingly distributed from Kiel, and it was probably by means of this that a faint comet, supposed to be Tuttle's, was discovered March 5th, by Dr. Wolf, as already announced. This ephemeris, as corrected by Dr. Wolf's observation, is given below.

Ephemeris.

G. M. T.		R. A.			Dec.		
1899. Mar.	5.5	1 ^h	16 ^m	39 ^s	+ 31°	36'	
	9.5	1	31	31	+ 30	58	
	13.5	1	46	31	+ 30	16	
	17.5	2	1	35	+ 29	30	

HARVARD COLLEGE OBSERVATORY,
March 8, 1899.

A NEW STAR IN SAGITTARIUS.

FROM an examination of the Draper Memorial photographs, Mrs. Fleming has discovered a new star in the constellation Sagittarius. Its position for 1900 is: R. A. = 18^h 56.2^m, Dec. = -13° 18'. It was too faint to be photographed on eighty plates taken between October 18, 1888, and October 27, 1897, although stars as faint as the fifteenth magnitude appear on some of them. It appears on eight photographs taken while it was bright. On March 8, 1898, it was of the fifth magnitude, and on April 29, 1898, of the eighth magnitude. A plate taken this morning, March 9, 1899, shows that the star is still visible, and is of the tenth magnitude. Two photographs show that its spectrum resembles those of other new stars. Fourteen bright lines are shown, six of them due to hydrogen. The entire number of new stars discovered since 1885 is six, of which five have been found by Mrs. Fleming.

E. C. PICKERING.

HARVARD COLLEGE OBSERVATORY,
March 9, 1899.

NOTES ON PHYSICS.

ELECTRIC WIRE WAVES.

THE theory of electric waves along wires has been worked out very completely by J. J. Thomson for the case of a wire surrounded by a cylindrical conducting shell. A further development of the theory, together with some interesting numerical results is given by A. Sommerfeld in *Wiedemann's Annalen*, 1899, No. 2. The author gives a rigorous solution of Maxwell's equations for electric waves transmitted along a straight wire of great length. This rigorous solution leads to an equation in Bessel's functions, the roots of which give the velocity of transmission and the damping coefficients. The author gives approximate solutions of this equation for wires of great conductivity, diameter of wire being rather small compared to the wave-length, and for wires of medium conductivity, diameter of wire being very small compared to wave-length. In these two cases the equation in Bessel's functions reduces to a logarithmic form for which the roots may be found without serious difficulty.

The author gives the following calculated results: Electric waves of 30 cm. wave-length travel along a copper wire of 4 mm. diameter at a velocity which is less than the velocity of light by one part in 30,000, and the amplitude falls to $\frac{1}{2.8}$ of its initial value at a distance of 1.5 kilometers.

Electric waves of 100 cm. normal wave-length (period $33 \cdot 10^{-10}$ second) travel at about three-quarters of the velocity of light along a platinum wire .004 mm. diameter, and their amplitude falls to $\frac{1}{2.8}$ of its initial value at a distance of only 17 cm.

The author also gives a diagram of the lines of electric force inside and outside of the wire, the lines of magnetic force being circles around the wire.

W. S. F.

A NEW INDICATOR FOR ELECTRIC WAVES.

A GALVANOMETER of medium sensitiveness is connected to a battery, a strip of silvered glass is included in the circuit and the coating of silver is scratched across so as to break the circuit. The strip is placed in moist air and the galvanometer shows a deflection. When the strip is

exposed to electrical waves the galvanometer deflection is suddenly reduced to nearly zero; and when the waves cease the galvanometer deflection is quickly reestablished. This effect is described by A. Neßgeschwender (*Wiedemann's Annalen*, 1899, No. 2), and the author finds that the film of moisture recovers its electrical conductivity so quickly after the cessation of the electrical waves that a telephone in circuit with the silvered strip gives the tone of the induction coil break even when the frequency of the break is very great.

W. S. F.

THE ELECTRIC DISCHARGE IN RAREFIED GAS.

MATHIAS CANTOR (*Wiedemann's Annalen*, 1899, No. 2), has shown by means of the coherer (a mass of powdered metal forming a portion of an electric circuit), that the electric discharge produced through a vacuum tube by a large storage battery gives off electric waves. This discharge must, therefore, be either oscillatory or intermittent, contrary to the notion which has heretofore prevailed.

W. S. F.

BRILLIANCY OF LIGHT SOURCES.

In *Wiedemann's Annalen*, 1898, No. 13, Mr. P. Jenko gives a curiously roundabout method for the determination of the intrinsic brightness or brilliancy of light sources. Before entering into the details, however, it is necessary—such is the confusion of photometric terminology—to state a few definitions. The *brightness* of a source here signifies the total amount of light given out by that source and is ordinarily measured in candles. The *intensity of illumination* of a surface is the amount of light falling upon unit area of the surface and is usually measured in candles per square centimeter. Thus the intensity of the illumination of a surface distant one meter from a standard candle (assumed to give off light equally in all directions for the sake of brevity of statement) is

$$\frac{1}{126000} \frac{\text{candle}}{\text{cm}^2}.$$

This intensity of illumination is universally but irrationally called the *candle-meter*. The *brilliancy* of a light source is the amount of light given off from each unit area of its luminous surface. This, also, is to be expressed in candles per square centimeter. The candle per square centimeter is a convenient unit for expressing brilliancy of light sources,

but is an inconveniently large unit for expressing ordinary intensities of illumination. Thus, easy reading requires about $\frac{1}{10000}$ candle per square centimeter.

Instead of determining the brilliancy of a light source by dividing its measured brightness (candle power) by the measured area of its luminous surface, making due allowance, of course, for irregular distribution in so far as this is possible, Mr. Jenko illuminates a screen of known area by a light of measured brightness, distance being measured. The intensity of the illumination of this screen is then known. He then compares upon a photometer bar the light given off by this screen with the light given off by the source of which the brilliancy is to be determined. He then measures the luminous area of the source and calculates its brilliancy in terms of the brilliancy of the illuminated screen, using an obvious relation between brilliancies, brightnesses and distances along the photometer bar!

W. S. F.

THE MAGNETIZATION OF IRON.

In *Wied. Ann.*, Band 66, No. 13, pp. 859–953, Max Wien communicates the results of a most careful and elaborate investigation upon 'The Magnetization of Iron by Alternating Currents.' The first part of the paper contains a general *résumé* of the literature of the subject, with a useful set of references to the original articles. Following this comes a discussion of the magnetization of iron by alternating currents, in which it is shown that for a coil containing an iron core and having a purely sinusoidal E. M. F. applied to it, neither the induction nor the magnetizing force will be a simple sine function of the time, but will contain higher harmonics, on account of the varying permeability of the core, and that also the apparent resistance of such an electro-magnet is greater than the resistance of its windings, while its apparent is less than its true self inductance.

A full description of the experimental arrangements and necessary corrections for Foucault currents, upper harmonics, etc., is then given together with the values obtained for the induction and hysteresis for irons of various qualities, using magnetizing currents having frequencies of 128, 256 and 520 per second.

The paper concludes with a general discussion of the experimental data, which may be summarized as follows:

The permeability and induction are always smaller for an alternating field than for a steady one, the difference reaching a maximum for low values of the magnetizing force, while near saturation the difference is small. For low values of the magnetizing force the differences are the same for all frequencies. The softer and less subdivided the iron, and the higher the frequency, the greater the difference (amounting in one case for very soft iron to 40%).

In moderate and strong fields, for equal values of the induction, the hysteresis is greater for alternating magnetization, than the value obtained by the usual static methods, the increase being greater the nearer saturation is approached, the higher the frequency and the softer the iron. The opposite is true for weak fields.

The only explanation which can be given is that the magnetism of the iron is unable to keep up with a rapidly varying field and consequently the hysteresis loop is broader and lower than it would be if determined for slow changes of the field.

A. ST. C. D.

GENERAL.

H. BECQUEREL (*Comptes Rendus*, t. CXXVII., p. 899 and t. CXXVIII., p. 145) has been able to prove and study the existence of abnormal dispersion in sodium vapor. He finds that the effects of the D_1 and D_2 lines in causing abnormal dispersion are superposed and that for certain rays the refractive indices are less than unity.

ON account of its importance in the theory of atmospheric electricity the question as to whether the vapor of an electrified liquid is itself electrified is of great interest. It cannot be said that the subject has not received attention, but the results obtained by different investigators are not in accord. Pellat (*Comptes Rendus*, t. CXXVIII., p. 169) has lately re-investigated the subject and finds that the rate of loss of charge from an insulated, electrified, metal vessel is greater when it contains water than when empty. Applying this result to the phenomena of atmospheric electricity he comes to the conclusion that it can

only explain a part of the observed facts and further knowledge will reveal some as yet unknown cause acting.

A. ST. C. D.

SCIENTIFIC NOTES AND NEWS.

MR. HENRY GANNETT, Geographer of the Geological Survey, who was the political and statistical geographer of the last census, has been asked to take charge of the same work for the coming census. The Director of the Census Mr. Merriam, has announced that all applications for positions will receive consideration, and that examinations will be held as rigid as those before the Civil Service Commission. The 300 Supervisors are to be appointed after consultation with Senators and Representatives of the separate States, but without regard to party affiliations.

THE professors of geology in the University of California and in Stanford University have organized a geological club, to be called the 'Cordilleran Geological Club.' It is intended to include all the geologists of the Pacific and adjacent States, and its object is by occasional meetings to stimulate geological work. Whether it shall remain an independent organization or shall be affiliated with any other scientific body is left for future decision.

PROFESSOR RAY LANKESTER has been elected Foreign Correspondent of the Paris Academy of Sciences for the Section of Anatomy and Zoology. Twenty-seven votes were cast for Professor Lankester and eight for Professor Van Beneden, of Liège. M. Lortet, professor of medicine, of Lyons, has been elected National Correspondent for the same Section.

LORD LISTER, London, and Professor Koch, Berlin, have been elected Foreign Associates of the Paris Academy of Medicine.

PROFESSOR RAY LANKESTER, London; Professor L. Cremona, Rome, and M. Alexander Karpinsky, St. Petersburg, have been elected Associates of the Belgian Academy of Sciences.

THE address in medicine at the next Yale commencement exercises is to be delivered by Professor Charles Sedgwick Minot, of the Harvard Medical School. The title of the address has not yet been announced, but we are in-

formed that Dr. Minot will present some new aspects of medical education.

PROFESSOR GEORGE T. LADD, of Yale University, will be given a year's leave of absence at the close of the present academic year, and will lecture on philosophical subjects before the Universities of Japan and India.

DR. WILLIAM T. HARRIS, United States Commissioner of Education, has been given an honorary doctorate of philosophy by the University of Jena.

MR. W. E. D. SCOTT has been appointed curator of the ornithological collection in the School of Science of Princeton University.

MR. A. E. BOSTWICK, Librarian of the New York Free Circulating Library, has been elected Librarian of the Brooklyn Public Library.

THE Permanent Secretary of the American Association for the Advancement of Science, Dr. L. O. Howard, Department of Agriculture, Washington, D. C., would be glad to receive information of the present addresses of the following: Mr. William J. Lewis, Mr. Frank McClintock, Miss Mary A. Nichols, Mr. Charles M. Rolker and Mr. Carl H. Schultz.

SIGNOR RODOLFO LANCIANI, D.C.L., LL.D., professor of ancient topography in the University of Rome and Director of the Italian School of Archæology, has been appointed Gifford lecturer in the University of St. Andrews for the next two academical years. The subject of his lectures will be the 'Religion of Rome.'

WE learn from *Nature* that at the anniversary meeting of the Royal Astronomical Society, Mr. Frank McClean, F.R.S., was awarded the gold medal of the Society for his photographic survey of stars in both hemispheres, and other contributions to the advancement of astronomy. A prize of 500 francs, founded by Augustin-Pyramus de Candolle for the best monograph on a genus or family of plants, is offered in competition by the Société de physique et d'histoire naturelle de Genève. The monographs may be composed in Latin, French, German, Italian or English, and must be sent to M. Pictet, the President of the Society, before January 15, 1900. Members of the Society

are not permitted to compete. The Belgian Royal Academy has awarded prizes of 600 francs to M. Georges Clautriau, of Brussels, for his memoir, on the macro- and micro-chemistry of digestion in carnivorous plants, and to Professor L. Cuénot, of Nancy, for his essay on the excretory organs of Mollusca.

WE regret to record the death of Sir Douglas Galton, F.R.S., the eminent sanitary engineer. Born in 1822, he was educated at Rugby and Woolwich, and received a commission in the Royal Engineers in 1840. He subsequently served in many important capacities as Inspector of Public Works, visiting the United States to inspect the railways in 1856. He was the author of books on 'Healthy Dwellings' and 'Healthy Hospitals.' Sir Douglas Galton was for twenty-five years the General Secretary of the British Association, and on his retirement, in 1895, was elected President. It will be remembered that his presidential address at Ipswich was published in this JOURNAL.

SIR JOHN STREUTHERS, emeritus professor of anatomy in the University of Aberdeen, died on February 24th, aged 75 years. He was the author of numerous papers on human and comparative anatomy, and exercised much influence on the improvement of anatomical teaching in Scotland.

THE deaths are also announced of Dr. Dareste de la Chavanne, the French anthropologist, and Dr. Franz Lang, a Swiss zoologist and geologist.

A GRANT of £300 from the Worts Travelling Scholars' Fund, Cambridge University, has been made to Mr. W. W. Skeat, M.A., towards defraying the expenses of his scientific expedition to the Malay peninsula, on the condition that the results of the investigations made by the expedition be reported by him to the Vice-Chancellor in a form that may hereafter be published. Mr. Skeat is accompanied by two zoologists, Messrs. Evans and Annandale, of Oxford, and by Mr. Gwynne-Vaughan, botanist.

NEWS of the safety of M. Bonin, the French explorer, who has been missing in Thibet and the interior of China, has reached Shanghai. He arrived at Yachow, Sye Chuen district, after many exciting experiences, and will make his

way to the coast by the river route. With a few Chinese companions he has travelled through the greater portion of Thibet and made a trip from the Siberian line to Tong King.

STEPS have been taken by the British government to guard against undue destruction of wild animals in Africa, by the issue of game regulations. The German government has been consulted, and it is proposed to hold an international conference on the subject in London in the spring.

THE New York Post-Graduate Hospital has received \$100,000 from Mr. Harris Fahenstock for a training school for nurses.

PROFESSOR R. W. WOOD, of the University of Wisconsin, has discovered a new method of photographing in natural colors. He reproduces the colors by diffraction, and, though at present the production of the first finished picture is somewhat tedious, duplicates can be printed as easily as ordinary photographs are made. The pictures are on glass, and are not only colorless, but almost invisible when viewed in ordinary lights, but when placed in a viewing apparatus, consisting of a convex lens on a light frame, show the colors of nature with great brilliancy. The principle is that the picture and the lens form spectra which overlap and the eye placed in the overlapping portion sees the different portions of the picture in color depending on the distance between the grating lines at that place. Professor Wood says the finished picture is a transparent film of gelatine with very fine lines on it, about 2,000 to the inch on the average. The colors depend solely on the spacing between the lines, and are pure spectrum colors, or mixtures of such, the necessity of colored screens or pigments, used in all other processes except that of Lippman, having been overcome. The pictures can be projected on a screen by employing a suitable lantern, or can be viewed individually with a very simple piece of apparatus consisting of a lens and perforated screen mounted on a frame. A peculiarity of the process is that there is no such thing as a negative in it. Half-a-dozen pictures have been printed in succession, one from another, and all are positive and indistinguishable from each other.

THE record for kite-flying for scientific purposes has again been broken at the Blue Hill Observatory; 12,440 feet above the sea-level was reached on February 28th by a recording instrument attached to a string of tandem kites. This is 366 feet higher than the preceding best record, made at the same place on August 26th. The flight was begun at 3:40 p. m., Tuesday, the temperature at the surface being 40° and the wind seventeen miles an hour. At the highest degree the temperature was 12° and the wind velocity fifty miles an hour. Steel wire was used as a flying line, and the kites, four in number, were of an improved Hargreave pattern, with curved surfaces, made after the pattern of soaring birds' wings. The upper kite carried an aluminum instrument weighing four pounds, which recorded graphically temperature, wind velocity, humidity and atmospheric pressure. The combined kites had an area of 205 square feet and weighed twenty-six pounds, while the weight of the wire was seventy-six pounds. The upper kite remained above two miles for about three hours, and was reeled in by a steam windlass, constructed for that purpose. When within half a mile of the ground the fastening on one of the kites slipped, and this carried it up to the one above, the added pull snapping the wire and sending three kites adrift. A search for the lost kites was begun on Wednesday, and two of them were found at the Milton town farm, about two miles away, but the third was not recovered until later, when it was found at Field's Corner, over six miles north of the Observatory, or more than half the distance between that point and the State House. The recording instrument was found uninjured. This was the last of a series of five high flights made on successive days, Sunday excepted. The average height reached was 10,800 feet, or nearly two miles. The temperature at 10,000 feet on February 23d was 5°; on the 24th, 1°; on the 25th, 11°, and on the 28th, 20° above zero.

THE *British Iron Trade Journal* attributes the remarkable expansion of the iron and steel industries of the United States to the following favorable changes in economic conditions: (a) 'Intensive' production, reducing costs generally; (b) Reduced costs of ores and develop-

ment of the deposits of fine mineral in the district adjacent to the Great Lakes; (c) Reduction of salaries through technical progress and changes in systems of administration; (d) Remarkably low cost of fuel; (e) Concentration of production with unlimited capital; (f) Mainly, however, to reduced cost of transportation. This last factor more than all others together has brought about this great change and placed the United States in its present relation to the world's markets.

In a note by M. Considère, published in the *Moniteur Industrielle*, recently, there are given the data of tests of mortars and cements in structures, their resistance being reinforced by the introduction of iron straps and 'armatures,' which show that, as he states, these substances may be thus caused to sustain tensions twenty times as great as when not thus reinforced.

It appears that the Nernst light, the scientific principles of which we recently described, is likely to rival the arc lamp for general use. Companies have been organized in Germany, Great Britain and America with capitals extending into the millions of dollars. The English company values its rights at about \$1,300,000, and it is to be hoped that Professor Nernst receives the greater part of this sum.

Knowledge states that a site has been secured at Kemp Town, overlooking Queen's Park, Brighton, for the Gardens of the recently founded Zoological Society for Brighton and Hove. Some sixty years ago Brighton possessed a small zoological garden situated north of The Level, on the Lewes Road. The institution did not flourish owing to the ignorance of its originators, who had no notion of the proper method of dealing with captive specimens. The consequence was a very high death-rate and a brief career for the institution. The new garden will not be likely to fail from the causes which produced the collapse of its predecessor, for it will be managed by competent zoologists who have experience in the treatment of animals of all kinds. Moreover, the encouragement held out to the projectors by residents and persons of distinction in Brighton is such as to warrant us in believing that the undertaking

will prove to be a success in all respects. A special feature in the new institution will be the regular delivery of courses of instructive popular lectures for the benefit of the numerous schools in Brighton and Hove. Among those who have enrolled their names as patrons of the Society are several of the foreign Ambassadors, the Duke of Fife, Sir John Lubbock, Sir Edward Sassoon, the Earl of Chichester and the Hon. Walter Rothschild. The managing-directors are the Earl of Landaff and Mr. F. W. Frohawk.

THE New York *Medical Record* states that the Japanese parliament has passed a bill authorizing the free distribution of vaccine virus and rendering vaccination compulsory. It is provided that a child must be vaccinated within ten month of its birth, and that, if the vaccination does not take, it must be repeated within a period of six months, and yet again within a similar period if it be again unsuccessful. Further, all children must be re-vaccinated at the age of six and once more at the age of twelve. Thereafter vaccination becomes occasional, and may be declared compulsory at any time of threatened or actual epidemic, the power to order it being vested in local governors.

A COURSE of nine lectures upon science and travel has been arranged by the Field Columbian Museum, Chicago, for Saturday afternoons in March and April at 8 o'clock. The lectures are as follows:

March 4—'Cuba and the Cubans,' Dr. R. S. Martin, Chicago.

March 11—'Blind Fishes of North American Caves,' Dr. Carl H. Eigenmann, Director, Biological Station, Bloomington, Indiana.

March 18—'Religious Ceremonies of the Hopi Indians of Arizona,' Dr. George A. Dorsey, Curator, Department of Anthropology, Field Columbian Museum.

March 25—'Colors of Flowers and Fruits,' Professor W. H. Dudley, Wisconsin State Normal School.

April 1—'Russia and the Russians,' Professor A. M. Feldman, Armour Institute of Technology.

April 8—'The Bad Lands of South Dakota,' Professor O. C. Farrington, Curator, Department of Geology, Field Columbian Museum.

April 15—'Extinct Vertebrates of the Bad Lands,'

Mr. E. S. Riggs, Assistant Curator of Paleontology, Field Columbian Museum.

April 22—'Animal Messmates and Parasites,' Professor H. M. Kelly, Cornell College, Mount Vernon, Iowa.

April 29—'Aboriginal Methods of Manufacturing Weapons and Implements,' Professor George L. Collie, Beloit College, Wisconsin.

UNIVERSITY AND EDUCATIONAL NEWS.

MR. W. F. R. WELDEN, F.R.S., professor of zoology of University College, London, has been elected Linacre professor of comparative anatomy at Oxford, in succession to Professor Ray Lankester. Professor Welden, Professor Love, whose appointment to the Sedleian chair of natural philosophy we announced last week, and Mr. Stout, recently appointed to the Wilde lectureship of mental philosophy, were all Fellows of St. Johns College, Cambridge.

THE following promotions have been made at Princeton University: Assistant Professor Herbert S. S. Smith to be professor of applied mechanics in the School of Science; Assistant Professor Walter Butler Harris to be professor of geodesy in the School of Science, and Instructor Ulric Dahlgren to be assistant professor of histology in the academic department.

E. L. THORNDIKE, PH.D. (Columbia), instructor in Western Reserve University, has been appointed instructor in genetic psychology in Teachers College, Columbia University.

THE Isaac Newton Scholarship of Cambridge University for the encouragement of study and research in astronomy has been awarded to Mr. G. W. Walker, B. A. Scholar of Trinity College. The scholarship is of the annual value of £200, and is tenable for three years.

MISS CAROLINE HAZARD, of Peacedale, R. I., has been elected President of Wellesley College.

PROFESSOR SNELLEN will retire at the close of the present semester from the chair of ophthalmology at the University of Utrecht.

AT a recent meeting of the Council of New York University Chancellor MacCracken reported that endowments amounting to nearly \$50,000 had been received, of which \$20,000

will be devoted to the School of Applied Science.

A CHAIR of English Literature has been endowed in Princeton University with \$100,000, on condition that the Rev. Dr. Henry Van Dyke, of New York City, be the first incumbent. Princeton University has also received \$65,000 for the academic department.

THE German-American citizens of New York are collecting a fund of \$20,000 in honor of Mr. Carl Schurz, whose seventieth birthday was recently celebrated. The money will be used to endow a fellowship and a Library of Germanic Literature in Columbia University.

THE following further gifts have been made during the week to educational institutions: \$50,000 to the Catholic University by the National Council, Knights of Columbus, to establish a chair for historical research; \$20,000 to Hobart College for the foundation of scholarships by Miss Catherine L. Tuttle; \$10,000 to University of Virginia for books on the history of Virginia, and \$5,000 from various donors to Syracuse University.

AT congregation at Cambridge University on March 2d the report of the General Board of Studies recommending the establishment of a department of agriculture in the University under the direction of a professor was approved. The offers made to the University by Sir Walter Gilbey, the Board of Agriculture, certain county and borough councils and the Drapers' Company were gratefully accepted.

THE plans for the Cornell Medical School, New York City, have been filed. The entire frontage on First avenue, between Twenty-seventh and Twenty-eighth streets, is to be occupied by the building, which will cost \$500,000.

Erratum: In the abstract (p. 312 above) of Professor Wm. A. Locy's paper before the American Morphological Society, 'New Facts Regarding the Development of the Olfactory Nerve,' the first sentence should read: 'The early embryonic history of the olfactory nerve is very imperfectly known,' instead of 'is known,' and the closing sentence should read: 'It was also shown to persist in the adult,' instead of 'to perish in the adult.' Credit should also be given to the Elizabeth Thompson Science Fund for providing the material upon which the research was conducted.

1

OTHNIEL CHARLES MARSH, Professor of Paleontology in Yale University, President of the National Academy of Sciences from 1883 to 1896, President of the American Association for the Advancement of Science in 1878, and one of the editors of this JOURNAL, died at New Haven on March the eighteenth, in his sixty-eighth year.

SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; J. LE CONTE, Geology; W. M. DAVIS, Physiography; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SQUIDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; HENRY F. OSBORN, General Biology; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; J. MCKEEN CATTELL, Psychology; DANIEL G. BRINTON, J. W. POWELL, Anthropology.

FRIDAY, MARCH 24, 1899.

CONTENTS:

<i>The Early Tertiary Volcanoes of the Absaroka Range:</i> ARNOLD HAGUE.....	425
<i>The Physiological Basis of Mental Life:</i> PROFESSOR HUGO MÜNSTERBERG.....	442
<i>Sophus Lie:</i> PROFESSOR GEORGE BRUCE HALSTED	447
<i>Scientific Books:—</i>	
<i>Newbigin on Color in Nature:</i> PROFESSOR T. D. A. COCKERELL. <i>Weir on the Dawn of Reason:</i> DR. EDWARD THORNDIKE.....	448
<i>Scientific Journals and Articles:</i>	450
<i>Societies and Academies:—</i>	
<i>The Annual Meeting of the New York Academy of Sciences:</i> PROFESSOR RICHARD E. DODGE. <i>The Philosophical Society of Washington:</i> E. D. PRESTON. <i>The Geological Society of Washington:</i> DR. WM. F. MORSELL.....	452
<i>Discussion and Correspondence:—</i>	
<i>On the Making of Solutions:</i> PROFESSOR M. A. WILLCOX. <i>The Origin of Nightmare:</i> G. V. D.....	455
<i>Astronomical Notes:—</i>	
<i>A New Satellite of Saturn:</i> PROFESSOR E. C. PICKERING.....	456
<i>Notes on Physics:—</i>	
<i>The Nernst Lamp; Pyroelectricity and Piezoelectricity; The Rotary Converter; The Telescope-Mirror-Scale Method:</i> W. S. F.....	456
<i>Notes on Inorganic Chemistry:</i> J. L. H.....	457
<i>Current Notes on Meteorology:—</i>	
<i>The Theory of Cyclones and Anticyclones; Carbonic Acid in Death Gulch:</i> R. DEC. WARD...	458
<i>Zoological Notes:—</i>	
<i>Neomylodon Listai:</i> F. A. L.....	459
<i>Scientific Notes and News:</i>	460
<i>University and Educational News:</i>	464

THE EARLY TERTIARY VOLCANOES OF THE ABSAROKA RANGE.*

It is, I suppose, accepted by many geologists that volcanic energy has played an important part not only in bringing about the present configuration of the Rocky Mountains, but in building up the entire northern Cordillera, stretching from the Front Range, along Colorado, Wyoming and Montana, westward to the Pacific Ocean. Over this wide area the volcanic phenomena of Tertiary time present a varied and complex mode of occurrence, offering from different points of view many problems of geological interest. These problems have been vigorously attacked both in the field and in the laboratory, and something has been accomplished tending toward their final elucidation. The literature upon the subject is already voluminous, being scattered widely through the publications of official reports, both State and National, and in the proceedings of scientific societies. While I desire to call your attention to some of these features, I do not propose to summarize the work that has already been done in this direction in a manner which is perhaps usual on occasions like the present. Neither do I wish to review the field from my own standpoint, possibly because, although much has been accomplished, such a vast amount of work remains to be done that the broad

*MSB. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

*Address of the President before the Geological Society of Washington, February, 1899.

field seems even yet scarcely explored. I prefer, therefore, to place before you some results of personal observation in a region in which I have worked for several years and in which I have become deeply interested.

The Absaroka Range lies along the east side of the Yellowstone Park. Several of its higher peaks and its long western spurs, sloping gradually toward the Park, lie within the national reservation. During several successive summers, while engaged in geological observations in the Park, I found it necessary to penetrate beyond its boundaries into the higher encircling mountains. My first excursion into the Absarokas was undertaken in the summer of 1885, and thereafter for several years I made long and protracted journeys into this rugged and at that time almost unknown region, studying its geology, and returning each year more and more profoundly impressed by its many marvels. In the year 1893, and again in 1897, the greater part of the summer was occupied in exploration of the wild recesses of the Absarokas.

The range, which lies wholly in the State of Wyoming, stretches from the Beartooth and Snowy ranges, on the north, southward to the Owl Mountains. In width it is less sharply defined, certain outlying plateau-like areas, such as Mirror and Two-Ocean plateaus, being separated from the main body by deep valleys. Geographically they may be considered as distinct physical features. Geologically, from their mode of occurrence and the nature of the rocks, they are intimately associated with the central mass, and for the purposes of this address they may be considered as forming a part of the Absaroka Range. As thus defined, the range measures 80 miles in length by 50 miles in width, covering an area of nearly 4,000 square miles.

From one end to the other the Absarokas present a high, imposing plateau, with ele-

vations ranging from 10,000 to over 12,000 feet above sea level. This entire mass is made up almost exclusively of Tertiary igneous rocks. Near the northern flanks Archean schists and gneisses crop out from beneath the overlying rocks. Resting upon the Archean, upturned Paleozoic limestones and sandstones having a considerable thickness come to the surface, and along the eastern borders of the range, exposed by erosion in the broader valleys, occur Cretaceous rocks. With these exceptions, the range consists of a vast accumulation of agglomerates, tuffs, lava flows and intrusive masses.

Degradation of the mass has taken place on a grand scale. Vast quantities of volcanic ejectamenta have been removed from the summit, but no reliable data exist by which the amount can be estimated even approximately. All the higher portions have been sculptured by glacial ice. Enormous amphitheatres have been carved out of the loose agglomerates, and peaks, pinnacles, and relics of great tablelands testify in some measure to the forces of erosion. The plateau is scored by a complete network of deep valleys and gorges, which dissect it in every direction and lay bare the structure of the vast volcanic pile.

Nowhere in the northern Rocky Mountains do I know grander and more rugged scenery than can be found in the Absarokas. But few natural passes lead across the mountainous tract, and these are high and difficult to scale. For years the range stood as an impassable barrier to the earlier explorers in their attempts to reach the sources of the Yellowstone from the east; and even to-day the region is seldom penetrated to its inmost recesses except by those engaged in scientific exploration of the country, by the prospector in search of precious metals, or by a few adventurous sportsmen in pursuit of the big game of the Rockies. Much of this region is covered by a dense growth of

coniferous forest, and the greater part of the forests lying east of the Yellowstone Park belong to the Yellowstone timber reserve, the first of the forest reservations set aside by proclamation of the President under the Act of Congress approved March 1, 1891.

Rightly to understand the true position of this volcanic area it is necessary to review briefly the geological history of the surrounding region before the piling-up of the eruptive material. The Absarokas are hemmed in, both to the north and to the south, by high ranges with approximately east and west trends. On the north are the Beartooth Mountains, presenting a broad elevated Archean mass culminating in some of the highest peaks to be found in Montana; while to the south are the Owl Mountains, consisting of an Archean nucleus capped and for the most part concealed by an arch of Paleozoic beds highly inclined along the outer edges. Between these two ranges lies a depressed basin, and resting unconformably upon the Archean are sediments of great thickness, derived in large part from the earlier continental areas.

These sediments, slowly deposited throughout a long period, represent nearly all the great divisions of Paleozoic and Mesozoic time. Beginning with the Cambrian, in their order of sequence, come the Silurian, Devonian, Trias, Jura and all the epochs of the Cretaceous recognized in Wyoming and Montana including the Dakota, Colorado, Montana and the Laramie sandstone at the top, with its frequent fluctuations of sea level, foreshadowing changes in the development of the pre-existing continental area.

With the close of the Laramie sandstone the long-continued deposition of Mesozoic and Paleozoic sediments finally came to an end. In this region unconformity of sediments by deposition has not as yet been recognized, and in this sense alone they may be said to be conformable from Middle

Cambrian time to the summit of the Laramie. Stupendous orogenic movements took place, and the surrounding country became one of mountain building on a grand scale, accompanied by plication, folding and faulting. The evidence all points in one direction—that this uplifting was contemporaneous in all the ranges of the northern Rocky Mountains. For this reason, and owing to its great geological significance, being one of the most important in Rocky Mountain geological history, the uplifting has been designated as the post-Laramie movement.

Along the west side of the Absarokas, and lying within the Yellowstone Park, extend north and south ridges of faulted and crumbled strata consisting mainly of highly inclined Cretaceous sandstone, the Laramie, nearly 10,000 feet above present sea level. From this ridge region eastward for fifty miles stretches this broad volcanic mass, finally dying out upon the plain over which the earliest lavas spread, resting on horizontal sandstones at an elevation of about 6,000 feet above sea level. After a very considerable erosion of the uplifted Mesozoic continental land area began the earliest of these volcanic eruptions, which later displayed such marvelous energy over this entire region of country, and which were closely related to the post-Laramie movement. This eruptive material, forcing its way upward, followed lines of least resistance along or near planes of faulting, or wherever the strain had been greatest upon the weakened strata.

The Absaroka Range was formed by the piling-up of successive accumulations of volcanic ejectamenta, with occasional interbedded flows of lava, burying everything beneath them to a depth of several thousand feet. Volcanic breccias, agglomerates and extrusive lavas, or those that have been poured out and cooled near the surface, constitute the bulk of the mountains.

These breccias and lavas were ejected from numerous fissures, vents and centers of explosive energy. Infinite detail as regards mineral composition and texture, and great complexity in mode of occurrence, may be observed. Viewed in a broad way and reduced to its simplest terms, the Absaroka Range consists of an uplifted volcanic region, presenting from one end to the other great uniformity, and even simplicity, in its main geological features. It is essentially a dissected plateau, deeply trenched by incisive gorges, offering exposures varying from 2,000 to 5,000 feet of nearly horizontal or only slightly inclined lavas. To this there are, of course, some exceptions, as is natural in any volcanic region. Notwithstanding the varied and complex manifestations of the eruptive breccias from many sources of outflow, this entire body of extrusive material has been divided broadly into six epochs, based upon their relative age and general sequence of lavas. They represent, in the geological history of the mountains, as many distinct phases of volcanic eruption. Beginning with the earliest in the order of eruption, they have been designated as follows: early acid breccia, early basic breccia, early basalt sheets, late acid breccia, late basic breccia, late basalt sheets.

Briefly stated, the interpretation of this history, as I understand it, is somewhat as follows:

So far as is known, the oldest volcanic rocks recognized in the Absarokas consist of a series of eruptives made up almost entirely of fragmental material, usually light in color, varying from grayish white to purple. In mineral composition they range from hornblende-andesite to hornblende-mica-andesite. Some of the siliceous varieties have developed phenocrysts of quartz in sufficient amount to be classed as dacites. These breccias appear to have been thrown out with violent explosive action from nu-

merous centers, but from none of them was any large amount of material piled up; at least if it was thrown out it was subsequently worn down by atmospheric agencies. In no instance do they attain great elevation, the exposures being due to extensive erosion and deep trenching of narrow canyons. They are known only in the northern end of the range, and there in limited area, being buried beneath vast accumulations of still later material. These centers appear to be independent of later eruptions.

Overlying these acid breccias is a vast amount of volcanic ejectamenta, with here and there interbedded basaltic flows, the entire body having accumulated in many places to a height of several thousand feet. They occur far more widely distributed over the mountains than any other group of breccias, stretching both in its length and breadth from one end of the range to the other. They constitute nearly all the northern portion of the Absarokas, as well as the northeast corner of the Park. Unlike the early acid breccia, they are usually dark colored, owing to the amount of ferro-magnesian minerals present. The material consists largely of hornblende-pyroxene-andesite, pyroxene-andesite and basalt. Constant modifications and transitions occur, but over the entire area the prevailing rock is pyroxene-andesite, passing into slightly less basic rocks carrying hornblende on the one hand and into basaltic forms on the other. By far the greatest portion of this eruptive material is formed of coarse agglomerates, sombre in color, held together by varying amounts of cementing ash and silts of similar composition. The prevailing colors are black and brownish gray, while the finer silts and mud flows free from large boulders are light brown, in strong contrast to the mass of the breccia.

It is difficult to describe in few words such volumes of volcanic material scattered

over broad fields and thrown out under varying conditions. Frequently these basic breccias present a rough and ropy surface, like ordinary scoria irregularly heaped together, but the bulk of it indicates indistinct bedding. A tumultuous heaping-up of agglomerate by explosive action characterizes this breccia, which not infrequently carries andesitic and basaltic boulders measuring 5 and 6 feet in length and often double that size. In one or two localities huge boulders of crystalline gneisses and schists are also embedded in the lavas.

Scattered over the area occur the thin interbedded flows, apparently poured forth from numerous fissures and vents. These flows increased in frequency and thickness until finally massive outflows of basalt covered a considerable portion of the earlier series of breccias. Over how large a field they at one time may have extended cannot now be told, erosion having certainly removed them from large tracts, but they may never have been spread over extensive regions. It is somewhat curious that this continuous broad field of basalt has a north-west-and-southeast trend and stretches obliquely across the summit of the range from Mirror Plateau to Needle Mountain, whereas the body of the breccia in general has a north-and-south trend. The basalts lie upon the uneven surfaces of the breccia and occur piled up in a succession of flows, which in places near their sources have attained an aggregate thickness of 1,500 feet, although over large areas they measure about 1,000 feet, thinning out to a few hundred, while in certain places they appear to be wanting. Individual sheets range in thickness from 5 to 50 feet without showing any material change in the physical characters of successive flows. The greatest accumulation of flows appears to be along the trend of the basaltic body, thinning out both to the northeast and to the southwest, indicating that the eruptions had followed

a fissure or system of fissures. Of course, this can be said only in a general way, as basaltic outflows may occur anywhere along the range. As regards mineral composition, they are usually fine grained, with but few well-developed megascopic constituents, mainly augite, olivine and plagioclase. In chemical composition they show within restricted limits considerable variation, with accompanying changes in mineral development, analyses determining a large amount of the alkalis and a correspondingly low percentage of silica. Numbers of these flows have built up, from vents, rounded bosses of basaltic rocks characterized by a development of orthoclase, in several instances associated with leucite. They are the extrusive equivalents of intrusive rocks, designated as *absarokites* in distinction from normal basalts. Reference will be made to them later, in speaking of certain intrusive masses. So far as our present knowledge goes, they belong chiefly to this period of eruptions. Many of these individual sheets stretch out for long distances, but others show great lack of continuity, thinning and thickening in different directions and often overlapping one another, indicating numerous sources of eruption and varying force and duration of flows.

In their topographic configuration the basalts stand out in marked contrast to the loosely compacted breccias, owing to great uniformity of flows and to differences in weathering. To these basalts the name *early basalt sheets* has been given, and they are here treated as a geological unit, since they mark a distinct period in the history of volcanic eruption. It is quite possible, and even probable, that they covered this entire region and were subsequently removed by erosion, but of this there is no direct evidence. If they did, the country must at one time have presented a gloomy, sombre field of basalt, poured forth in a molten condition after a long period of fragmental

eruptions. How long the basalt period lasted cannot now be told. In determining the sequence of lavas these early basalt fields play an important part, as they overlie the early series of acid and basic breccias and underlie a somewhat similar series of eruptive material designated late acid breccia and late basic breccia and flows.

Following the basalts come the late acid breccias. They occur less widely distributed than the early acid breccias, and for the most part lie within the Yellowstone Park. Unlike the earlier breccias, they are less deeply buried beneath later eruptive material, but are piled up in successive layers one upon another, forming the summits of several prominent peaks and broad, plateau-like ridges. Over considerable areas they lie spread out in thin sheets over the basalt flows. Their centers of eruption occupy a restricted area and seem to be in every way quite independent of the earlier breccias and basalts. In mineral composition they closely resemble the early acid breccias, consisting of hornblende-andesite and hornblende-mica-andesite, in places mingled with a good deal of pyroxene-andesite, both augite and hypersthene being recognized, sometimes one and sometimes the other predominating. Much of the brecciated material is similar in mineral composition to the Ishawooa intrusive bodies, which will be discussed later. Nearly all of this material is fragmental, and the greater part of it is made up of coarse and fine tuffs. Frequently the contact between the light-colored acid breccia and the still later basic breccia is sharply drawn, the latter filling up depressions and levelling the accidented surfaces of the former, which occur at varying altitudes. In most instances the line of demarcation is not so sharply drawn, and not infrequently there is a mingling of material, as if there had been a pouring-out of the later rock before the complete cessation and

closing-up of the more acid centers of eruption. Occasionally these light-colored rocks, from what appear to be local centers, lie directly upon basic breccia made up of basaltic boulders and cementing tuffs of the earlier series, without the intervening basalts. Overlying these acid breccias there poured forth from numerous vents a second great volume of basic rocks and agglomerates, 2,000 to 3,000 feet in thickness, bearing a close resemblance to the earlier basic rocks. They are found over the southern portion of the Absarokas, usually resting upon the basalts, the late acid breccias being, as before mentioned, restricted to a limited region of country. Indeed, the second series of breccias forms the top of nearly all the high plateaus and the summits of the more prominent points. Cross-sections exposed in deep canyons reveal grand escarpments of both breccias, with intervening monotonous sheets of basalts. Viewed in a broad way, these two series of breccias are singularly alike, and apparently the conditions governing their eruptions were much the same. If we are to draw any distinctions, it may be said that the early breccias are apt to be scoriaceous and slaggy and more chaotic in their tumultuous accumulation. The later breccia is more regular and distinctly bedded, and is almost wholly made up of both coarse and fine fragmental material, carrying large boulders that could not have been thrown a great distance from the discharging vents. Boulders weighing a ton or more are by no means uncommon. In general, it may be said of these later breccias that the coarsest material lies near the present crest of the range, and is seen to grow finer and more uniform, with distinct bedding, as one travels either east or west. To this rule, however, there are marked exceptions.

Following the late basic breccia, basalt tables are found here and there capping the

crest of the main ridge along the southern portion of the range. Probably they are all remnants of one continuous flow. They are best observed when seen eastward from Mountain Basin, when they present a castellated appearance, capping the coarser and lighter-colored rocks. In general habit they resemble the earlier basalt sheets, and, except for their position, have little to distinguish them from other similar flows. The part they play in the present configuration of the plateau is insignificant. The interest lies in the fact that these basalts complete a second cycle of eruption, which built up the Absarokas by the accumulation of successive flows of extrusive lavas, and that with them, so far as we have any positive record, the last phase of a long-continued series of eruptions came to a close.

That the piling-up of this eruptive material lasted through a long period of time is clearly established. In the first place, the early acid breccias show evidences of considerable denudation before the pouring-out of later lavas which now occupy the eroded areas. Not infrequently depressions may be seen filled with water-laid silts and fine gravels, which were afterwards covered by fresh outflows of breccia. Similar water-laid deposits may be observed in all the breccias, but they especially characterize the early basic series along the east side of the range, where the former existence of large lakes and ponds is manifest, with sediments of volcanic material over 200 feet in thickness deposited in comparatively quiet waters. In certain localities the basalts appear to be the result of fitful discharge and slow building-up from numerous vents. The thinning and thickening of beds in various directions, the overlapping of thin beds from different centers, and the frequently chilled surfaces of vesicular basalt, all point to a slow accumulation of the ejected lava. Occasionally in basaltic

cliffs between lava sheets may be seen thin beds of volcanic sands and gravels, wind-strewn over an exposed surface before being buried beneath fresh flows. Nowhere were interbedded layers of clay or earthy beds of decomposed rock observed, but such deposits are, I think, exceptional in most basalt areas.

While the gradual building-up of the plateaus from fresh accumulation was steadily in progress, erosion was constantly at work upon the surface; and, although volcanic fires ceased long ago, erosion has been going on steadily ever since. One of the most remarkable and puzzling features of the country are the areas of undoubted water-worn volcanic material, with its smooth and polished boulders. Accumulations through floods and freshets abound; and, besides the evidence of ancient lakes and ponds found dotted over the surface, there are strong grounds for the belief that upon the upland existed broad rivers which carried the water-laid material across the plateau to the plain below. All this required a long time for its accomplishment.

Turning now to the land vegetation, convincing arguments are found not only for determining the age of the rocks, but for demonstrating that the eruptions lasted throughout a long continued period of activity. It is doubtful if any other known region in the world offers such a promising field of research, showing the relationship between plant life and volcanic eruptions, as is to be found in the Absarokas. In solving these problems the geologist is greatly indebted to the paleobotanist. From time to time extensive collections of fossil plants have been made, indicating a rich and varied flora. Portions of the region have been visited by our distinguished fellow members, Professor L. F. Ward and Professor F. H. Knowlton. All of the collections have been referred to Professor Knowlton, who has made an exhaustive

study of the material, and his researches are now in press. For specific determinations of these plants I refer you to his monograph. Already over 150 species of plants have been identified.

The early acid breccias have yielded a terrestrial vegetation regarded as of earlier age than that obtained from the superimposed lavas. It has furnished a grouping of species so closely allied to the flora found in the Fort Union beds, near the junction of the Yellowstone and Missouri Rivers, that the two floras are regarded as identical in age, and consequently referred to the Eocene period. From these acid breccias eighty species have been identified, and twelve of them were previously only known as belonging to the Fort Union horizon. Still others are common to both localities, but are found elsewhere as well. About one-half of the species are new to science, but according to Professor Knowlton their biological affinities relate them closely to the Fort Union flora. A second grouping of fossil plants, designated for convenience the intermediate flora, flourished at a time when the early acid breccia had about ceased to be emitted; at least they occur near the base of the lower basic breccia in beds indicating a mingling of both types of rock. In all probability they represent a flora which flourished in quiescent times, during a transition period from one series of eruptions to another, but foreshadowing a period of basic eruptions. This flora is of the highest geological significance, since it indicates a great duration of volcanic activity, with a change of climatic and physical conditions. This intermediate flora embraces about thirty species, of which only two or three are as yet known in the acid breccias. About the same number have been recognized as common to the basic breccias, but the evident affinities of the grouping are such that the flora as a whole is apparently more closely allied to

the overlying than to the underlying rocks. For this reason it is referred to the base of the Miocene period and is regarded as older than the flora of the auriferous gravels of California.

The vegetation which flourished during the period of the basic breccias was, like the breccias themselves, widely distributed over the mountains wherever mud and silts were present to furnish a suitable soil. Nowhere can it be better studied than at the fossil forest of Specimen Ridge, in the Yellowstone Park, first explored by Professor W. H. Holmes over twenty-five years ago. Since that time other localities have been discovered, and quite recently beds holding leaf impressions of a similar flora have been found on the east side of the mountains. At the fossil forest precipitous walls expose nearly 2,000 feet of horizontal beds of breccias, silts and mud flows, in part laid down by floods and freshets and in part deposited by quiet waters. From base to summit at frequent intervals a terrestrial vegetation has sprung up and flourished, only in turn to be destroyed by renewed lava streams. In one of these buried forests a stump of a still-standing coniferous tree measures 10 feet in diameter and is surrounded by many fallen logs long since preserved by silicification. If one considers the length of time it takes for any vegetation to spring up on an arid lava field and the great age of many of these trees, the time necessary to build up a series of such forests one above another can hardly be overestimated. That there were long periods of rest between the outpourings of the lava seems evident. Throughout this 2,000 feet of erupted material it has been found impossible as yet to discriminate between vegetation found at the base of the cliffs and that interbedded with the lavas at the summit. This implies similar climatic conditions during the time demanded to renew and develop a varied flora between

successive layers of tuffs and muds. It may be well to state that all this probably took place before the period of basalt eruptions. This flora has yielded seventy species, and is regarded as markedly different from that of the earlier breccia, and of later age. As a grouping it shows the closest affinity to the auriferous gravels of California, many of the species being identical, while still others have the closest resemblance to species found only in the gravels. It has been named the Lamar flora, and referred, like the auriferous gravels, to the upper Miocene period. Both the late acid and the late basic breccias have recently yielded well-preserved leaf impressions, proving the existence of a more or less luxuriant flora in all the great periods of breccia eruptions. Such fragmentary material as has been found in these later rocks agrees with plants preserved in the early breccia at Fossil Forest, and, therefore, has been correlated with the Lamar flora of upper Miocene age. It was a vegetation essentially characterized by deciduous foliage. Several species of magnolias, aralias and other equally important groups which are marked features of the auriferous gravels flourished on these volcanic slopes. Specimens of *Aralia notata* occur widely distributed, and the leaves of some of them are supposed to have measured 3 feet in length by 2 in breadth. Associated with them are leaves provisionally referred to the genus *Artocarpus*, indicating the presence of the breadfruit tree. According to Professor Knowlton, this flora is extra-tropical and may be compared in many ways to the vegetation as seen to-day in southern Mississippi and the Gulf coast. He says: "It is obvious that the present flora of the Yellowstone National Park has comparatively little relation to the Tertiary flora and cannot be considered as a descendant of it. It is also clear that the climatic conditions must have greatly changed. The

Tertiary flora appears to have originated, or at least to have had its affinities, at the south, while the present flora is evidently of northern origin."

On the slopes of Overlook Mountain, in the center of the range, nearly 11,000 feet above the present sea level, occurs a prostrate log, preserved by silicification, measuring 2 feet in diameter at its base. Not far distant other logs are found, and in the silts occur impressions of deciduous leaves. From this locality four species of plants have been determined as identical with species found in the fossil forest, among them an *Aralia notata*.

In a personal communication Professor Ward informs me that in his opinion the flora of this region grew virtually at sea level. While I recognize his eminent authority in such matters, I am hardly prepared to accept such a radical view, but I cordially welcome this expression of opinion because it in a measure corroborates my own belief that the silts and ashes on which the flora of Overlook Mountain flourished were laid down at a much lower level than that at which they are now found.

Briefly summarizing the facts brought out by a study of the fossil flora and their bearing upon the geology, it is, I think, indisputable that the flora affords abundant evidence of a great range of Tertiary time during the period of volcanic eruptions, even if geologists do hesitate to accept the precise determinations of the age of the different floras and their geological sequence. This luxuriant terrestrial vegetation, developed through thousands of feet of lava beds, tends to confirm the view that the accumulation of this erupted material was an exceedingly slow process. Again, the character of the vegetation lends a forcible argument to the belief that the entire region must have been elevated since the development of so varied an extra-tropical vegetation. For my part, I desire to pay tribute

to the great value of the fossil flora as an aid in deciphering the geological history of the Absarokas. Its interest and importance cannot be overestimated.

Only brief allusions have been made as yet to the intrusive bodies, although they play a most important part in the building-up of the Absarokas. Although such bodies in the form of dikes probably cut the breccias from time to time, it is clearly evident that all the large intrusions, together with the greater part of the dikes, were forced upward and into the breccias at two well-defined periods of eruption. The first of these periods was in part contemporaneous with the early basalt flows, and in part followed them. The second followed the late basic breccia and basalts, and, so far as can be told, completed the final chapter in the geological history of the immediate region. It is possible that later eruptions took place and that the material ejected was removed by erosion, but of this there is no positive record other than a few isolated patches of rhyolite which do not bear directly upon the problems before us and which may be regarded as outliers of the rhyolite of the Park plateau. It does not follow that the intrusions of either period were contemporaneous in age, but simply that they belong to a certain phase of the eruptive energy. Dikes may cut an earlier series of intrusives, and subsequently other dikes may intersect those which preceded them.

For the purpose of clearly discriminating between these two groups of rocks, the one that followed the early basic breccia has been named the Sunlight intrusives, from their remarkable exposures along Sunlight Creek and valley, while the later group has been named the Ishawooa intrusives, from the canyon of that name, where the complexity of their occurrences forms one of the most striking features of that impressive gorge. In mineral composition the

Sunlight intrusives range from a quartz-augite-andesite, through transition forms of syenite and diorite, to orthoclase-gabbro. The large body at the head of Sunlight Creek is mainly a syenite with associated monzonites and diorites. On Closed Creek, in Crandall Basin, the intrusive body consists for the most part of orthoclase, gabbro and diorite. The series as a whole shows an association of the minerals augite, plagioclase and orthoclase, with quartz and biotite in its more siliceous members, and olivine and hypersthene in its basic members. In general, the Sunlight intrusives are more diversified in chemical composition than those of the Ishawooa group. The latter are more siliceous, carrying less of magnesia and alkalis, and the coarsely crystalline masses are much more like normal diorite, diorite-porphry, granite, granite-porphry and andesite-porphry.

Of the Sunlight intrusive bodies the one situated near the source of Sunlight Creek, in the central portion of the range, is the most impressive, and at the same time the most typical in its occurrence. It measures nearly 3 miles in length and occupies the basins of all the deep glacial amphitheatres on the north side of Stinkingwater River, while all the high intervening ridges separating the basins consist of indurated breccia. Similar rocks are exposed in the Silvertip Basin, on the south side of the peak, and in all probability they form part of one continuous body.

The Crandall Basin stock, under Hurricane Mesa, exposed by the erosion of Closed Creek, has far less lateral expansion, but rises for nearly 3,000 feet above its base. Dikes radiate from all the large intrusive bodies, but nowhere else is their number so great and the part they play so strongly marked as in the region of the Sunlight stock. These dikes are by no means all connected with the large stocks seen at the surface, but may be observed in

great force at a number of localities in the early breccia along the east side of the range, far removed from any recognized crystalline body. Wherever these early breccias occur dikes are apt to be a marked feature of the country, in contradistinction to the country occupied by the latter breccias.

These dikes consist mainly of orthoclase basalts, which Professor Iddings, from his microscopical studies, has divided into absarokites, shoshonites and banakites, depending upon their varying mineral and chemical composition. In the field it seems impossible as yet to differentiate between them, and so far as can be told they present the same mode of occurrence. For most geological purposes they may be grouped together under the general term of absarokites. They form a connecting link between many of the eruptions in the early basalt sheets and the Sunlight intrusives. They are closely related to the syenites and monzonites of the Sunlight intrusive stock. Both these dikes and sheets occur over extensive areas.

Leaving for the present the Sunlight intrusives, let us take up the Ishawooa intrusives, which I select in order the more easily to bring out in detail certain facts bearing upon the origin of both types of intrusive rocks. Of the many intrusive bodies, Needle Mountain, in the southern end of the Absarokas, is the most imposing and instructive of them all. At the base runs the Shoshone River, through one of the most rugged and picturesque canyons to be found in northern Wyoming. This great stock, which stretches along the valley for nearly four miles, rises abruptly 4,000 feet above the stream bed, from an elevation of 7,000 feet above sea level. It is overlain by 1,000 feet of partially indurated and metamorphosed breccia. From the rounded summit of this commanding peak the breccias may be seen stretching far to the west on the opposite canyon wall,

thence across Thoroughfare Plateau and on to the higher regions of Wind River Plateau, where they lie nearly horizontal at an elevation approximately the same as that of Needle Mountain itself. Upon this latter plateau the Shoshone River finds its sources, and in its rapid descent of 5,000 feet before reaching Needle Mountain exposes large, irregular stocks of indefinite outline piercing the breccias.

Looking eastward from Needle Mountain, the breccias extend as far as the eye can reach in the direction of the broad, open plain beyond. The massive stock of Needle Mountain consists essentially of diorite, quartz-diorite and diorite-porphry, cut by numerous narrow dikes of apparently differentiated products of the same molten magma. Offshoots and apophyses from the parent stock pierce the surrounding breccia, and a number of small dikes penetrate the overlying breccia. From these dikes sheets of granite-porphry stretch out into the breccias, and on the spurs of the mountain erosion has worn them bare, leaving them exposed as the surface rock. The stock is found on the opposite side of the canyon, rising high above the stream and capped by the ever-present breccia. Bordering the diorite stock the breccias are indurated, crushed, and so altered that not infrequently it is impossible to discriminate between breccias and intrusive stocks without the aid of the microscope. Dr. Jaggar has shown that many of these fine-grained rocks are altered mud and silts and metamorphosed breccias.

From Needle Mountain to Mount Chitenden, in the Yellowstone Park, a distance of over fifty miles, there extends in a northwest direction a remarkable and probably a continuous belt of intrusive rocks. These intrusive bodies occur as stocks, sheets, bosses and dikes, varying from irregular-shaped masses of stupen-

dous proportions, two and three miles in width and several thousand feet in height, to narrow dikes and seams traceable along the canyon walls for only a few feet and often disconnected at the surface from any other body. A short distance north of Needle Mountain, but on the opposite side of the canyon, another great stock rises precipitously above the stream bed, and it is clearly evident that its relation to the breccias are in every way similar to those observed at Needle Mountain. Between these two massive bodies smaller outcrops of diorite and diorite-porphry are exposed in lateral ravines on the mountain sides, and the network of dikes trending in every direction points conclusively to the fact that these intrusive bodies belong to one and the same stock. Dislocated and indurated bodies of breccia are found upon the mountain spurs, but the overlying capping of breccia peacefully crowns it all.

From this point northward, following along the line of the powerful intrusions, each dissecting canyon, where it cuts the intrusive masses, lays bare numerous exposures of crystalline rocks which have forced their way upward into the breccias, and, following lines of least resistance, have spread out in all directions with a marvelous complexity of form and outline. Some of the stocks penetrating the breccia have attained elevations slightly above the present level of the plateau, but most of them failed to reach so high a position. Wherever they have reached the top of the plateau their tendency is to spread out in sheets, which now form the exposed surface of spurs and ridges. Many of these interbedded sheets are directly connected with some of the larger stocks, but others show no such relationship at the surface and stand out quite independently of them. Occasionally the sheets bulge up with irregular outline; others are dome-shaped, de-

veloping laccolithic form. Vertical dikes cutting the interbedded breccias pass into sheets, and later again assume the conditions of normal vertical dikes. The variable character of the breccia, sometimes compact and uniform and at others made up of an incoherent mass of silts and ash, tends to constant change in the upward movement of the molten magma.

The gorges of both Cabin Creek and Canyon Creek expose similar rocks, with accompanying phenomena of strain and rupture. Ishawooa Canyon, one of the most rugged of these incisive trenches, presents varied modifications of eruptive energy, a bold stock, Clouds Home, piercing the breccias with an irregular outline from the bottom of the canyon to the top of the plateau. One of the finest examples of a massive interbedded sheet extends for a mile or more along the canyon wall. Similar phenomena present themselves in Wapiti Canyon, where four tributary streams, uniting to make the river, have cut down in the intrusive masses in a most instructive manner. Near the sources of Eagle Creek diorite and andesite-porphry are again laid bare, and thence, trending across the crest of the range, extend as far as Sylvan Pass, where coarsely crystalline diorite and diorite-porphyrines come to the surface for the last time in an exposure nearly a mile in length. Beyond this point eruptive energy gradually dies out, and is only shown by the presence of a few powerful dikes noticeable for their uniformity and persistency.

A distinctive feature along this entire line of intrusive rock is the belt of indurated breccia which accompanies it. Near the larger stocks the alteration of the breccia is especially noticeable, and not infrequently it is difficult to discriminate between the stock masses and the metamorphosed material. The mode of weathering is so unlike that of the ordinary breccia,

and the transitions are so gradual, that it is by no means easy to define the outlines of the intrusive masses without personal inspection. Although never having been followed as a continuous body, owing to the nature of the topography, the zone of induration is one of the marked features of the region, and under favorable conditions may be traced in the canyon walls for fifty miles, with a width in places of more than one-half mile. Another important and significant feature is the inclination of the breccias away from some well-defined axis or central ridge. They do not as a rule arch over any single powerful protrusion, but present every indication of a broad anticlinal structure, with the piled-up lavas inclined toward the west and southwest on one side and toward the east and northeast on the other. Between the more massive bodies that have been forced upward to elevations above the general level there may be found areas of indurated breccia, traversed by a labyrinth of dikes and veins in their efforts to force their way upward.

Without entering into petrographic details, a few words in addition to what has already been said seem necessary. Granites and diorites are seldom met with other than in connection with the large uniform stocks. As most of these stocks are only partially exposed, their volume can only be a matter of conjecture, but in all the larger bodies, such as Needle Mountain, the rock is essentially that of a medium-grained diorite or diorite-porphphyry. A true granitic structure is by no means uncommon. Most of the powerful intrusions, as regards their crystalline structure, may be classed as granular. The great bulk of these crystalline rocks apparently carry some little groundmass. Porphyritic structure, with little groundmass, is a characteristic feature, with transitions into andesite-porphphyry and andesite. Many similar bodies of indefinite outline, only partially exposed by erosion

of the canyon walls, are andesites. Indeed, all the relatively small bodies are andesitic in habit, and the same is true of the many outlying bodies away from the general north-west-southeast trend of the intruded rocks.

A field study of these rocks of varying degrees of crystallization shows clearly that they were all exposed to virtually the same degree of pressure of overlying rock, and that their structural differences were not dependent primarily upon pressure from above. Many of these andesitic masses are much smaller than the diorite bodies and occur at much lower levels below the superimposed load. All observations upon the geological relations of these intrusives to the breccias tend to show that their structural differences are dependent far more upon the chilling effect of the surrounding rock and the rate of cooling than upon the pressure of the overlying rock. Geologists and petrographers have been for a long time investigating the structural differences and mineral variations of igneous rocks. Of these philosophical investigators Professor Iddings stands in the foremost rank. In an exhaustive petrographic study of the Crandall Basin intrusive body and its complex system of radial dikes of varying composition he reaches the conclusion that they have all been derived from the same parent molten magma, but crystallized under different conditions. With this conclusion I heartily agree. Dr. Jaggard, who has been at work upon a petrographical study of the intrusive rocks of the rest of the Absaroka Range, has reached a similar conclusion as regards the Ishawooa intrusive stock and associated sheets and dikes, and believes that they were derived from a common molten magma, which is quite in accord with geological observations in the field. From these observations, thus briefly and imperfectly stated, the conclusion seems inevitable that the Ishawooa intrusive, for its entire length of fifty

miles, represents a continuous ridge, the result of the consolidation of a molten magma intruded into the breccias. Erosion has as yet laid bare only the more elevated portions and some of the connecting links.

If a trained geologist were to stand on any one of the more prominent points in the Absarokas his attention would, first of all, be attracted by the vast amount of fragmental ejectamenta lying with apparent horizontality in every direction. Closer observation would impress him with the bedded nature of much of this material and the action which running water had played in disintegrating the lava and rounding the andesitic and basaltic boulders. If, by chance, he had acquainted himself with the huge stocks exposed in the canyons, knowing the power of dense crystalline rocks to withstand atmospheric agencies better than the easily disintegrating breccias, he would be surprised to find that none of the larger ones towered above the plateau in commanding peaks. At one or two localities they attain the present level of the plateau, but do not rise much above it, and usually give evidence of the dying out of the energy which forced the magma upward. As these intrusive stocks are overlain by breccia sometimes 1,000 feet in thickness, it is difficult to see how they ever could have been centers of powerful extrusive eruption.

In an address delivered before the British Association for the Advancement of Science in September, 1893, Professor Iddings took the ground that the Crandall Basin stock was the core of a grand volcano, from which issued the breccias, silts and tuffs which have built up the north end of the range, while the gabbros and diorites represent the coarsely crystalline development of that portion of the magma which cooled at great depths beneath the surface. He reconstructed a volcano to a height of 10,000 feet above the plateau, and subsequently removed by erosion every vestige of the

volcano down to the summit of Hurricane Mesa, the present level of the plateau. He likens it, in magnitude and in the processes by which it was built up, to the volcanoes of *Ætna* and *Vesuvius*. An abstract of the address was published in the *Journal of Geology* for September and October, 1893, and in a forthcoming report on the geology of the Yellowstone National Park a detailed description of the Crandall stock will be found, together with the results of his admirable petrographic studies of the rocks, to which allusion has already been made. After what has been said, it seems hardly necessary to add that with these geological views of Professor Iddings I do not agree. My interpretation of the history of this region may possibly call forth the friendly criticism that this address is an account of the early Tertiary volcanoes of the Absarokas with the volcanoes left out. For such criticism there may be some slight ground; but, while I fail to see any evidence of the building-up of such volcanic piles as *Vesuvius* and *Ætna*, or, as I should prefer to put it, volcanoes of the type of *Rainier*, *Hood* or *Shasta*, there was displayed intense explosive energy accompanied by immense volumes of steam and the piling-up of a vast block of lavas from many centers of activity. Instances of such explosive energy may be seen at *Chaos Mountain*, but the material thrown out yielded readily to atmospheric agencies and soon became spread out over the entire region. The whole area of the late acid breccia suggests several powerful vents for the ejection of fragmental material and the partial wearing-away of mounds and ridges of the heaped-up accumulations. It is possible that before the *Sunlight* and *Ishawooa* intrusives were forced upward volcanoes existed, but that any one or two of them dominated the region and influenced the topographical configuration of the Absarokas is exceedingly doubtful. There is noth-

ing to indicate the characteristic slopes of a great volcano.

Within the Yellowstone Park and just west of the Absarokas occurs a fine example of a volcano, situated near the intersection of the prolongation of the Ishawooa intrusive body and the fault along the southern slope of the Snowy Range. Mount Washburne is the culminating point of the volcano, which consists almost wholly of fragmental early basic breccia. From a well-recognized crater, since partially filled with rhyolite, the erupted material has been thrown out in every direction, building up true volcanic slopes encircling a central discharging vent. Such a structure I have never been able to recognize in the Absarokas. Mount Sheridan, in the Park, is another large volcano, but this is a Pliocene eruption consisting wholly of rhyolite, and is one of the sources of the great body of rhyolite which built up the Park plateau probably long after the Absarokas ceased to be a center of volcanic action.

Of all known regions of eruptive energy within historical times, Iceland in many ways affords the best field for comparison of the volcanic phenomena of to-day with conditions as they existed during the early Tertiary time in the Absarokas. Iceland is one of the active centers of eruption on a stupendous scale. It offers a continuous volcanic history throughout Pleistocene time, and dates back to the early Miocene, as is indicated by its fossil flora. In early Tertiary time the island was a region of profound faulting, and it is supposed to have been separated from the mainland during that period. Dr. Thoroddsen, the Icelandic geologist, has published in European scientific journals most interesting accounts of his explorations over the less-known regions of the island. The most complete and instructive of these accounts which has come to my attention was published by the Stockholm Society of Science

in 1888. Notwithstanding the volcanoes of majestic proportions which contribute so much to the scenic grandeur of Iceland, and which must give to all geologists who have seen them a profound sense of the power of volcanic energy, Dr. Thoroddsen, who has lived among them, protests against the idea that they were built up like Vesuvius or *Ætna*. He says: "The vast lava waste of Odadahraun was produced by the eruption of over twenty volcanoes, and perhaps many of the oldest centers of eruption that contributed to the formation of this desert have become obliterated by later lava streams. When one recalls geological text-book descriptions of modern volcanoes and their activity, it is nearly always Vesuvius that everywhere turns up like a spectre, whereas the regular volcanic cone composed of alternating lavas and tuffs is rather rare in Iceland."

The country which he is describing may be about one-half the size of the Absaroka Range, but I have no maps or accurate data for determining the area. Again, later, he says: "Only a few old volcanoes are found having this form. In Iceland it is very generally found that the fissure has not given rise to the formation of any real volcano. The lava there has sometimes welled out along the entire length of the fissure without the formation of a crater, but mostly there has been formed a series of low slag cones at the points where the magna, by reason of the form of the fissure or for some other cause, found it easiest to break forth. Such rows of craters are found in all volcanic regions of Iceland." Another noticeable feature, even in the active regions of Iceland, is the ease with which sources of eruption may become obliterated by fresh flows from neighboring vents of discharge. According to Dr. Thoroddsen the famous Heckla itself is a long ridge built up by a chain of small craters along a line of fissure.

Sir Archibald Geikie, in his admirable

work on the Ancient Volcanoes of Great Britain, in comparing the volcanic phenomena of the Icelandic eruptions with those exhibited by the basalt plateaus of the British Isles, remarks: "It is, therefore, to the Icelandic types of fissure eruption, and not to great central composite cones, like Vesuvius or *Ætna*, that we must look for the modern analogies that would best serve as commentary and explanation for the latest chapter in the long volcanic history of the British Isles."

In comparing volcanic areas of Iceland with the phenomena exhibited in the Absaroka Range there is one striking difference to be noted. In the former the extravasated molten magma consists largely of basaltic flows, while in the latter one is constantly impressed by the enormous amount of brecciated rock emitted. It is estimated that four-fifths of these extrusive rocks which make up the range consist of coarse and fine breccias, silts and related ejectamenta. Dead Indian Peak, one of the dominating points of the range, rises more than 6,000 feet above the valley, presenting layers of breccia which in the aggregate measure nearly one mile in thickness. It is a very conservative estimate to place the volume of breccia at one-half mile in thickness over the entire region under discussion, which, it should be remembered, embraces not much less than 4,000 square miles. This only allows for erosion an amount equal to the highest plateau summit, but it is sufficient to give one an idea of its vast bulk. That the denudation from the top of the existing plateau was very considerable is unquestioned, but there exist, I think, no reliable data upon which to base even an approximate estimate of the amount. Possibly the country was at one time covered with a mantle of basalt, which, withstanding erosion, would, of course, protect the friable volcanic material throughout a long period.

It is evident that the granular rocks required for their uniform crystallization an overlying load of greater or less depth. For my own part, I am more or less skeptical as to the need of an immense thickness of overlying material to develop such uniform consolidation as is generally supposed to be necessary to produce the so-called plutonic rocks. At Needle Mountain the medium-grained granular diorite for the entire 4,000 feet of rock face is apparently the same throughout, whereas only a short distance from the mass and at a lower level small bodies of rock in cooling have developed a characteristic andesitic structure.

It must be borne in mind that all this material, of varied mineral composition, grouped together under the designation of breccias, was congealed and crystallized before it was hurled out by explosive action. This means stupendous crushing and crunching of the mass as it was forced upward, and disturbances of the first magnitude, which must have had their origin in great crustal movements. Whence came this enormous mass of brecciated rock? Twice during the long period of their eruptions these breccias had been invaded by enormous bodies of granular rock which had elevated the entire Absaroka Range, an elevation that was phenomenal in its nature and formed a part of the great series of orogenic movement which uplifted the northern Cordillera. This uplift was closely related to the post-Laramie movement, which was one of the most profound and far-reaching orogenic disturbances anywhere recognized by geologists.

Throughout this address the large individual protrusions into the breccia have been alluded to as stocks, but I regard them as the more elevated portions of a great complex of crystalline rocks underlying at least a large part of this region of country. Where the underlying molten magma was subjected to the severest pres-

sure the material was squeezed upward to higher levels, following lines of least resistance, and consolidated at greater or less depths beneath the surface. This upward movement was probably coincident with the crustal movements that elevated the entire Absaroka Range. The line of Ishawooa intrusives marks the trend of one such upward movement of molten magma, which for the most part congealed without finding egress to the surface. That a portion of the magma may have been pushed upward through fissures and vents and discharged as surface flows of andesite is possible, but of such flows, if they existed, no positive evidence remains.

Conditions somewhat similar to those found in the Absarokas are described by Professor Adolph Stelzner as occurring in the Andes of Argentina. He describes granites, diorites and syenites as penetrating the andesitic tuffs and lavas of Tertiary age, and as cooling under a heavy load of superimposed material. He does not regard these massive crystalline bodies as conduits of volcanoes, but as large stocks formed independently of such vents. He refers to them as taking part in the great orogenic uplift which elevated the Cordillera of South America, an uplift which began in Jurassic time, lasted through the Mesozoic, and continued through the greater part of the Tertiary.

In the discussions of volcanic phenomena found throughout geological literature, circular vents of great depth seem to be regarded as indispensable and are supposed to furnish an open door for the molten magmas, permitting them to take a straight shoot from the eternal depths to daylight. In this way geologists certainly avoid many perplexing physical problems which confront us in the case of stocks and laccoliths penetrating sedimentary rocks and stopping far short of the surface. In speaking of areas of igneous rocks, one almost hesitates to use the term laccoliths, so universally is

it referred to in its relation to sedimentary rocks. For my part, it seems far more reasonable to look for such intrusive bodies in areas of igneous rock than in regions of sedimentation. That large intrusive bodies came to a standstill without any surficial manifestations, in the Absarokas, is, I think, fairly well determined.

Two years ago it was my good fortune to cross the Cascade Range at a number of localities and to climb far above timber line the slopes of Mount Rainier, in Washington; Mount Hood, in Oregon, and Mount Shasta, in California. From these commanding points comprehensive panoramic views were obtained over a broad field of igneous rock. Majestic and impressive as are these volcanoes, and grand in their isolation, I could but feel that back of them all lay earlier chapters in the Tertiary history of volcanic energy on the Pacific side of the Cordillera; that these powerful volcanoes were but a late expression of the intensity of the eruptive energy, and that still earlier volcanic masses had in some way taken part in the orogenic disturbances of an earlier Tertiary time. - So, on the east side of the great Cordillera, the early Tertiary fires long since ceased to glow in the Absarokas, and the center of volcanic energy moved westward and built up on different lines the broad rhyolite plateau of the Yellowstone Park, a plateau strongly contrasted with the Absarokas in the almost entire absence of breccias. The work of such investigators as Emmons and Cross in Colorado and Weed and Pirsson in Montana is slowly but surely solving the problems of the post-Cretaceous uplift in the northern Cordillera, and, it will, I think, finally be shown that the crystalline rocks consolidated below the surface have played an important part in bringing about the Cordilleran revolution.

On a bright crisp autumnal day in 1897 I left the Absarokas by the way of that

most interesting of valleys, Clark's Fork of the Yellowstone, still impressed with the many unsolved problems connected with the geology of the range. I at first visited the region in the expectation of finding a partially submerged range of Paleozoic and Mesozoic sediments. If ever such range existed, it had completely disappeared by profound subsidence. I then looked for the roots of some powerful dominating volcano which had been the source of the varying breccias, but this also I failed to discover. In its stead, if I interpret the facts correctly, I found penetrating the breccias the towering domes and pinnacles of granular and porphyritic rocks, which in some far-distant day, when denudation has removed a greater part of the overlying mass, may be found to form one connected body which erosion has already so far laid bare as to indicate that they all form a part of one broad complex of coarsely crystalline rock of early Tertiary age.

ARNOLD HAGUE.

U. S. GEOLOGICAL SURVEY, WASHINGTON, D. C.

*THE PHYSIOLOGICAL BASIS OF MENTAL LIFE.**

IF we demand a physiological process corresponding to every possible variation of the content of consciousness the structure of the brain seems far too uniform to furnish a sufficient manifoldness of functions. The mere number of elements cannot be decisive; if they are all functionally coordinated they can offer merely the basis for coordinated psychical functions. If we have psychical functions of different orders it would not help us even if we had some millions more of the uniform elements. It would be useless to deny that here exists a great difficulty for our present psychology; the only question is whether this difficulty really opposes the demands and supposi-

*Read before the joint meeting of the Psychological Association and the Physiological Society.

tions of psychophysical parallelism or whether it means that the usual theories of to-day are inadequate and must be improved. It seems to me that the latter is the case, and that hypotheses can be constructed by which all demands of psychology can be satisfied without the usual sacrifice of consistency. The situation is the following:

The whole scheme of the physiologists operates to-day in a manifoldness of two dimensions: they think the conscious phenomena as dependent upon brain excitements which can vary firstly with regard to their localities and secondly with regard to their quantitative amount. These two variations then correspond to the quality of the mental element and to its intensity. In the acoustical center, for instance, the different pitch of the tone sensations corresponds to locally different ganglion cells, the different intensities of the same tone sensation to the quantity of the excitement. Association fibers whose functions are not directly accompanied by conscious experiences connect these millions of psychophysical elementary centers in a way which is imagined on the model of the peripheral nerve. No serious attempt has been made to transcend this simple scheme. Certainly recent discussions have brought many propositions to replace the simple physiological association fiber which connects the psychophysical centers by more complicated systems—theories, for instance, in regard to the opening and closing of the connecting paths or in regard to special association centers or special mediating cell groups—but these and others stick to the old principle that the final psychophysical process corresponds to the strength and locality of a sensory stimulation or of its equivalent reproduction, whatever may have brought about and combined the excitements.

It is true that it has been sometimes suggested that the same ganglion cell may go

over also into qualitatively different states of excitement, and thus allow an unlimited manifoldness of new psychophysical variations. But it is clear that to accept such an hypothesis means to give up all the advantages of brain localization. The complicatedness of the cell would be in itself sufficient to give ground to the idea that its molecules may reach some millions of different local combinations, and if every new combination corresponds to a sensation all the tones and colors and smells and many other things may go on in one cell. But, then, it is, of course, our duty to explain those connections and successions of different states in one cell, and that would lead to thinking the cell itself as constructed with millions of paths just like a miniature brain; in short, all the difficulties would be transplanted into the unknown structure of the cell. If we, on the other hand, do not enter into such speculations the acceptance of qualitative changes in the cell would bring us to the same point as if we were satisfied to speak of qualitative changes of the brain in general. It would not solve the problem, but merely ignore it, and, therefore, such an additional hypothesis cannot have weight.

The only theory which brings in a really new factor is the theory of innervation feelings. This well-known theory claims that one special group of conscious facts, namely, the feelings of effort and impulse, are not sensations and, therefore, not parallel to the sensory excitements, but are activities of consciousness and parallel to the physiological innervation of a central motor path. At this point, of course, comes in at once the opposition of the philosophical claim that every psychical fact must be a content of consciousness, and made up of sensations, that is, of possible elements of idea, to become describable and explainable at all. The so-called active consciousness, the philosopher must hold, has nothing to do with an activity of the

consciousness itself, as consciousness means, from the psychological standpoint, only the kind of existence of psychical objects. It cannot do anything, it cannot have different degrees and functions, it only becomes conscious of its contents, and all variations are variations of the content, which must be analyzed without remainder into elements which are theoretically coördinated with the elements of ideas, that is, with the sensations, while consciousness is only the general condition for their existence. But also the empirical analysis and experiment of the practical psychologist are in this case in the greatest harmony with such philosophical claims and opposed to the innervation theory. The psychologist can show empirically that this so-called feeling of effort is merely a group of sensations like other sensations, reproduced joint and muscle sensations which precede the action and have the rôle of representing the impulse merely on account of the fact that their anticipation makes inhibitory associations still possible. It would thus from this point of view also be illogical to think the psychophysical basis of these sensations different in principle from that of other sensations. If the other sensations are accompaniments of sensory excitements in the brain the feelings of impulse cannot claim an exceptional position.

But are quality and intensity really the only differences between the given sensations? Can the whole manifoldness of the content of consciousness really be determined by variations in these two directions only? Certainly not; the sensations can vary even when quality and intensity remain constant. As an illustration we may think, for instance, of one variation which is clearly not to be compared with a change in kind and strength of the sensation; namely, the variation of vividness. Vividness is not identical with intensity; the vivid impression of a weak sound and the

unvivid impression of a strong sound are in no way interchangeable. If the ticking of the clock in my room becomes less and less vivid for me the more I become absorbed in my work, till it finally disappears, it cannot be compared with the experience which results when the clock to which I give my full attention is brought farther and farther away. The white impression, when it loses vividness, does not become gray and finally black, nor the large size small, nor the hot lukewarm. Vividness is a third dimension in the system of psychical elements, and the psychologist who postulates complete parallelism has the right to demand that the physiologist show the corresponding process. There are other sides of the sensation for which the same is true; they share with vividness the more subjective character of the variation, as, for instance, the feeling tone of the sensation or its pastness and presentness. Other variations bring such subjective factors into the complexes of sensations without a possibility of understanding them from the combination of different kinds only; for instance, the subjective shade of ideas we believe or the abstractedness of ideas in logical thoughts. In short, the sensations and their combinations show besides kind, strength and vividness still other variations which may best be called the values of the sensations and of their complexes. Is the typical theory of modern physiological psychology, which, as we have seen, operates merely with the local differences of the cells and the quantitative differences of their excitement, ever able to find physiological variations which correspond to the vividness and to the values of the sensations?

An examination without prejudice must necessarily deny this question. Here lies the deeper spring for the latent opposition which the psychophysiological claims find in modern psychology. Here are facts, the

opponents say, which find no physiological counterpart, and we must, therefore, acknowledge the existence of psychological processes which have nothing to do with the physiological machinery. The vividness, for instance, is fully explained if we accept the view that the brain determines the kind and strength of the sensation, while a physiologically independent subject turns the attention more or less to the sensation. The more this attention acts the more vivid the sensation; in a similar way the subjective acts would determine the feeling tone of the sensation by selection or rejection, and so on. While the usual theory reduces all to the mere association of locally separated excitements, such a theory thus emphasizes the view that the physiologically determined functions must be supplemented by an apperceiving subject which takes attitudes. We may call the one the association theory, the other the apperception theory. We have acknowledged that the association theory is insufficient to solve the whole problem, but it is hardly necessary to emphasize that the apperception theory seeks the solution from the start in a logically impossible direction, and is thus still more mistaken than the association theory.

The apperception theory, whatever its special label and make-up may be, does not see that the renunciation of a physiological basis for every psychical fact means resigning the causal explanation altogether, as psychical facts as such cannot be linked directly by causality, and that resigning the causal aspect means giving up the only point of view which comes in question for the psychologist. If those apperceptive functions are seriously conceived without physiological basis they represent a manifoldness which can be linked merely by the teleological categories of the practical life, and we sink back to the subjectifying view which controls the reality of life, but which

is in principle replaced by the objectifying view as soon as the experience of the subject is acknowledged as a series of psychological objects.

But does this bankruptcy of all varieties of apperception theories necessarily force us back to the association theory? I do not think so. The demand of the association theory that every psychosis should be accompanied by a neurosis cannot be given up, but this neurosis may be thought in a richer way than in the scheme of the associationists. It seems to me, indeed, that the physiological theory works to-day with an abstract scheme with which no observation agrees. We do not know of a centripetal stimulation which does not go over into centrifugal impulses. The studies on tonicity and actions of voluntary muscles, on the functions of glands and blood vessels, on tendon reflex centers, and so on, show how every psychophysical state discharges itself into centrifugal functions. And yet these perceivable peripheral effects are, of course, merely a small part of the centrifugal impulses which really start from the end stations of the sensory channel, as most of them probably produce only new dispositions in lower motor centers without going directly over into movement, and others may fade away in the unlimited division of the discharge in the ramification of the system. Those milliards of fibers are not merely the wires to pull a few hundred muscles; no, the centrifugal system represents certainly a most complex hierarchy of motor centers too, and the special final muscle impulse is merely the last outcome of a very complex cooperation of very many factors in the centrifugal system. Manifold as the incoming nerve currents must be, thus, also the possibilities of centrifugal discharge, and the dispositions in the nervous motor system determine the degrees in which the ganglion cells can transform the centripetal into centrifugal stimulation. It

is thus not only the foregoing sensory process, but in exactly the same degree also the special situation of the motor system, its openness and closedness, which governs the process in the center. Whether the special efferent channel is open or plugged implies absolutely different central processes in spite of the same afferent stimulus.

Here we have, then, a new factor on the physiological side which is ignored in the usual scheme that makes the psychical facts dependent upon the sensory processes only and considers the centrifugal action of the brain as a later effect which begins when the psychophysical function is over. There is no central sensory process which is not the beginning of an action too, and this centrifugal part of the central process necessarily varies the accompanying psychical fact also. As here the action of the center becomes the essential factor in the psychophysical process, we may call this view an action theory as over against the association and apperception theories of the day. The action theory agrees, then, with the associationism in the postulate that there is no psychical variation without variation on the physiological side and with the apperceptionism in the conviction that the mere association of sensory brain processes is insufficient to play the counterpart to the subjective variation of the psychical facts as vividness and values of the sensations. It tries to combine the legitimate points in both views, and claims that every psychical sensation as element of the content of consciousness is the accompaniment of the physical process by which a centripetal stimulation becomes transformed into a centrifugal impulse.

This central process thus clearly depends upon four factors: firstly, upon the local situation of the sensory track; secondly, upon the quantitative amount of the incoming current; thirdly, upon the local situation* of the outgoing discharge; and

fourthly, upon the quantitative amount of the discharge. The first two factors are, of course, determined by the incoming current, which can be replaced by an intracortical stimulation from an associated center, while the last two factors are determined by the dispositions of the centrifugal system. The association theory, which considers the first two factors alone, thinks them parallel to the kind and strength of the sensation. The action theory accepts this interpretation and adds that the two other factors determine the values and the vividness of the sensation—the values parallel to the local situation of the discharge, the vividness to the openness of the centrifugal channel, and thus to the intensity of the discharge.

If the centrifugal discharge is inhibited, the channel closed, then the sensory process goes on as before, but the impression is unvivid, unperceived, while it may become vivid later as soon as the hindrance of the discharge disappears. The inhibition of ideas which remains unexplainable to the associationists would then mean that a special path of discharge is closed, and thus the idea which needs that discharge for its vividness cannot come to existence; the hypnotizer's words, for instance, close such channels. Only discharges, actions, can be antagonistic and thus under mutual inhibition; ideas in themselves may be logically contradictory, but not psychologically, while one action makes the antagonistic action, indeed, impossible, and the inhibition of ideas results merely from the inhibition of discharges. If this view is correct it is clear that while we strictly deny the existence of special innervation sensations we can now say that every sensation without exception is physiologically an innervation sensation, as it must have reached some degree of vividness to exist psychologically at all.

With regard to the local situation of the motor discharge the manifoldness of pos-

sibilities is evident. The channels may be closed in one direction, but open in others; the actually resulting discharge must be the product of the situation in the whole centrifugal system, with its millions of ramifications, and the same sensory stimulus may thus under a thousand different conditions produce a thousand different centrifugal waves, all, perhaps, with the same intensity. The vividness would then be always the same, and yet the difference of locality in the discharge must give new features to the psychical element. A few cases as illustrations must be sufficient. We may instance the shades of time-direction; the same idea may have the subjective character of past, present and future. It corresponds to three types of discharge: the discharge which does not include action on the object any more appears as past; that which produces action as present, and that which prepares the action as future. In this group belong also the feeling tones: the pleasurable shade of feeling based on the discharge towards the extensors; the unpleasant feelings based on the innervation of the flexors. Here belong the differences between mere perception and apperception, as in the one case the discharge is determined by the impression alone, in the other case by associations also. Here belong the characteristics of the abstract conception which may be represented by the same sensational qualities which would form a concrete idea and yet has a new subjective tone because the centrifugal discharge is for the concrete idea a specialized impulse, for the conception a general impulse which would suit all objects thought under the conception. Here belongs, also, the feeling of belief which characterizes the judgment; the judgment differs psychophysically from the mere idea in the fact that the ideas discharge themselves in a new tonicity, a new set of the lower motor centers, creating thus a new

disposition for later reactions. To be sure, many of these discharges lead finally to muscle contractions which bring with them centripetal sensations from the joints, the muscles, the tendons, and these muscle and joint sensations themselves then become a part in the idea, for instance, of time, of space, of feeling. But the new part only reinforces the general tone which is given in the general discharge, and gives to it only the exact detail which gets its character just through the blending of these sensations of completed reactions with the accompaniments of the central discharge.

A consistent psychology thus may start with the following principles: It considers all variations of mental life as variations of the content of consciousness, and this content as a complex object, including in this first presupposition a complicated transformation of the real inner life, a transformation by which the subjectifying view of real life is denied for the causal psychological system. Every content of consciousness is further considered as a complex of sensations, that is, of possible elements of perceptive ideas. Every sensation is considered as having a fourfold manifoldness, varying in kind, in strength, in vividness and in value. The physiological basis of every sensation, and thus of every psychical element, is the physical process by which a centripetal stimulation becomes transformed into a centrifugal impulse, the kind depending upon the locality of the centripetal channel, the strength upon the quantity of the stimulus, the value upon the locality of the centrifugal channel, and the vividness upon the quantity of the discharge.

HUGO MÜNSTERBERG.

HARVARD UNIVERSITY.

SOPHUS LIE.

ON the eighteenth of February, 1899, the greatest mathematician in the world, Sophus Lie, died at Christiania in Norway.

He was essentially a geometer, though applying his splendid powers of space creation to questions of analysis. From Lie comes the idea that every system of geometry is characterized by its group. In ordinary geometry a surface is a locus of points; in Lie's *Kugel-geometrie* it is the aggregate of spheres touching this surface. By a simple correlation of this sphere-geometry with Pluecker's line-geometry, Lie reached results as unexpected as elegant. The transition from this line-geometry to this sphere-geometry was an example of contact-transformations.

Now contact-transformations find application in the theory of partial differential equations, whereby this theory is vastly clarified. Old problems were settled as sweepingly as new problems were created and solved.

Again, with his *Theorie der Transformationsgruppen*, Lie changed the very face and fashion of modern mathematics.

A magnificent application of his theory of continuous groups is to the general problem of non-Euclidean geometry as formulated by Helmholtz. To this was awarded the great Lobachévski Prize. Not even this award could sufficiently emphasize the epoch-making importance of Lie's work in the evolution of geometry.

Moreover, the foundations of all philosophy are involved. To know the non-Euclidean geometry involves abandonment of the position that axioms as to their concrete content are necessities of the inner intuition; likewise abandonment of the position that axioms are derivable from experience alone.

Lie said that in the whole of modern mathematics the weightiest part is the theory of differential equations, and, true to this conviction, it has always been his aim to deepen and advance this theory. Now it may justly be maintained that in his theory of transformation groups Lie has

himself created the most important of the newer departments of mathematics.

By the introduction of his concept of continuous groups of transformations he put the isolated integration theories of former mathematicians upon a common basis. The masterly reach of Lie's genius is illustrated by his encompassment of the fundamentally important theory of differential invariants associated with the English names Cayley, Cockle, Sylvester, Forsyth.

Thirteen years ago Sylvester announced his conception of 'Reciprocants,' a body of differential invariants not for a group, but for a mere interchange of variables. A number of Englishmen thereupon took up investigations about orthogonal, linear and projective groups, groups in whose transformations interchanges of variables occur as particular cases, and whose differential invariants are consequently classes of reciprocants, and of the analogues of reciprocants, when more variables than two are considered.

Now all these investigations were long subsequent to Lie's consideration of the groups in question as leading cases of a general conception. Thus they were merely secondary investigations!

Again, the theory of complex numbers appears as a part of the great 'Theorie der Transformationsgruppen.' Indeed, this continent of 'transformations' opened up and penetrated with such giant steps by Lie represents the most remarkable advance which mathematics in all its entirety has made in this latter part of the century.

Sophus Lie it was who made prominent the importance of the notion of group, and gave the present form to the theory of continuous groups. This idea, like a brilliant dye, has now so permeated the whole fabric of mathematics that Poincaré actually finds that in Euclid 'the idea of the group was potentially pre-existent,' and that he had 'some obscure instinct for it, without reach-

ing a distinct notion of it.' Thus the last shall be first, and the first last.

In personal character Lie was our ideal of a genius, approachable, outspoken, unconventional, yet at times fierce, intractable. His work is cut short; his influence, his fame, will broaden, will tower from day to day.

GEORGE BRUCE HALSTED.

AUSTIN, TEXAS.

SCIENTIFIC BOOKS.

Colour in Nature: A Study in Biology. By MARION J. NEWBIGIN. London, John Murray. 1898. Pp. 344.

On page 300 of this work we read: "We have now completed our general survey of the colours and colouring-matters of organisms. * * * That the survey as a whole is halting and incomplete must be obvious to all. We have seen that it is as yet impossible to classify pigments in a logical manner; that most of the problems connected with the subject are entirely unsolved." These statements are indeed true; and yet the book is an interesting and valuable one, and will be of real assistance to the working biologist.

The whole subject of color in animals and plants has suffered from the fact that it concerns the chemist and physicist as well as the biologist, and in these days of intense specialization it is hard to find anyone competent to treat the matter in all its aspects. Dr. Newbigin has endeavored, with some success, to take all the more important facts into consideration; but it is practically impossible for any one individual to have that intimate acquaintance with the vital phenomena of every group of living organisms which is necessary for a satisfactory discussion of their coloration. It was Darwin's method to seek the assistance of numerous specialists in different branches, who supplied him with information which he brought together and interpreted in a masterly manner. It may be that Dr. Newbigin has not yet felt justified in asking for such help, but now that she has fairly won her spurs (if one may use such a phrase in regard to a lady) it is not unreasonable to hope that she will adopt the Darwinian system, and eventually provide us

with an account of animal and plant coloration which will cover the ground as completely as the knowledge of the day permits. In the meanwhile, we may be grateful to her for a work which will at any rate serve as an excellent introduction to the subject, and as more or less of a revelation to those whose studies have been confined to a limited field.

Attention is drawn to the interesting analogy between natural color-variations of organisms and the changes which can be induced in their pigments by suitable reagents. This is a matter which, though well known, has not received the attention it deserves, partly because those aware of the chemical reactions have not usually been familiar with the natural variations, and *vice versa*. It may be permissible, by way of illustration, to cite two new instances of this among the Coccidæ which have just come to the writer's notice. *Icerya rileyi* has a pure white ovisac, which is turned bright primrose yellow by chloroform, but regains its white color when the chloroform evaporates. A closely related form, *Icerya littoralis*, var. *simosa*, has the whole ovisac naturally of a delicate primrose yellow. The second case is more instructive. *Mytilaspis concolor* has ordinarily a white scale, but on February 5, 1899, Mr. P. J. Parrott discovered a variety (*M. concolor* var. *viridissima*, Ckll. and Parrott, ined.) in which the scales of both sexes are of a lively emerald green. This was on the campus of the Agricultural College, Mesilla Park, at the bases of stems of *Atriplex canescens*. The female insect itself, removed from beneath the scale, was found to be of a dark purple color, with a bright yellow patch in the anal region, and suffused crimson spots at intervals round the margins of the hind end. The purple color, when the insect was placed in caustic soda, immediately became green, but was changed back to purple by acetic acid. Now, it is evident in this case that the insect must have had an acid reaction, but the pigment transferred to the scale had apparently been turned green by the 'alkali' salts which are known to occur in the soil at Mesilla Park. This at once recalls the chætopterin pigments described by Dr. Newbigin on pp. 89-91 of her work, and it may be that we have a new member of that series.

On pp. 161-162 it is suggested that the resemblance between certain Heliconian butterflies and their Pierid mimics may be due, at least in part, to their relatively low organization and simple plan of coloration. In the Transactions of the Entomological Society of London, 1891, Mr. H. H. Druce published a paper on the Lycænid genus *Hypochrysops*, which inhabits Australia and the Malay Archipelago. To this paper are appended two beautiful colored plates, and the present writer was surprised to find that he could nearly match a number of very diverse species figured, as to color and pattern, among a series of Lycænidæ collected in Jamaica! The resemblance pertained only to the upper surface of the wings, the lower surfaces of the Jamaican insects being quite unlike *Hypochrysops*. Now the Lycænidæ show splendid 'optical' colors, and are certainly not simply organized as regards their coloration, so the suggestion made with regard to the Heliconians and Pierids would not hold. Neither, of course, is there any true mimicry, since the two sets of butterflies occur on opposite sides of the world. Cases of this sort have been quoted as destructive to the theory of the utility of mimicry among insects, but to the writer they seem only to remove the difficulty which was felt in accounting for the origin of genuinely mimetic resemblances.

In a work of the kind now under review there must necessarily be details which could be adversely criticised. The writer had begun to take note of such, but it hardly seems worth while to dwell upon them. Botanists will undoubtedly complain that the space devoted to the colors of plants is much too short, and that several of the statements therein are too general or too sweeping. It will probably be thought by many readers that if Dr. Newbigin had made more or closer observations of living animals she would have had greater respect for natural selection. And, finally, some will wonder how it is that one who has enjoyed the beautifully pure colors of living creatures can have permitted her book to be bound in such a muddy and unpleasing blue.

T. D. A. COCKERELL.

MESILLA PARK, NEW MEXICO,
February 27, 1899.

The Dawn of Reason, or Mental Traits in the Lower Animals. By JAMES WEIR, M. D. New York, The Macmillan Co. Pp. xiii+234. Price, \$1.25.

Dr. Weir has evidently been a close observer of animal life for many years, and his zeal has given him wider opportunities for useful observation than most amateurs and many professional naturalists have had. His book contains the more important of his own original observations of the intelligent activities of animals, some interesting verifications of the results gained by other observers, and his opinions about the nature of animal consciousness. Everything is purposely put in as simple language as possible, and this perhaps is a sufficient reason for the utter neglect of many observations, experiments and opinions which oppose his views. Lloyd Morgan, for instance, is nowhere mentioned, not even in the bibliography.

The popular nature of Dr. Weir's exposition prevents any discussion here of his observations on the morphology of the sense-organs of various animals, *e. g.*, jelly-fish, grasshoppers, beetles. He finds the marginal bodies of jelly-fish to be visual, not auditory organs, locates the auditory organs of grasshoppers in the anterior pair of legs, finds those of the Diptera to be the 'balanciers' of Bolles Lee, and those of the *Cerambyx* beetle to be in the maxillary palpi. It would certainly seem worth while for Dr. Weir to present his data in complete form soon, so that those competent may judge of the soundness of his conclusions. He gives no drawings.

One cannot help lamenting the mental attitude which served as the inspiration to Dr. Weir's observations of the intelligent activities of animals. He craves a high development of mentality for the animals and has his eyes open only to possible evidence of it. He likes to find keen senses better than dull ones, reasonings than instincts, knowledge than ignorance. He psychologizes about animals as a lover might psychologize about his beloved. The disadvantages are obvious. On the other hand, there are some advantages, at least in the enthusiasm and patient labor which perhaps are due to the eulogizing temper. Anyone inter-

ested in the progress of comparative psychology must wish well to a man who, without the incentives of the professed naturalist, makes it a labor of love to watch animal life. I, for one, shall welcome such observations, even though they are more one-sided than Dr. Weir's. His favoritism toward animals, though it has deprived us of any records of unintelligent conduct and perhaps prevented the repetition of some tests and even distorted facts, has still failed to injure a very considerable number of suggestive and important observations. It will pay any student of animal psychology to read the book for the sake of these. They furnish interesting, and we hope reliable, data about the adaptive reactions of micro-organisms, the formation by insects of new associations in response to new situations, the formation by reptiles of habits due to the association of novel sights and sounds with certain reactions, about 'play' among insects, strange 'friendships' between animals, letisimulation, the activities of the harvesting ants, etc. A sample of Dr. Weir's keenness is his theory that the continual barking of dogs at night is explainable by the supposition that they bark at an echo. This hypothesis he supports by some very striking facts.

Of Dr. Weir's opinions about the meaning of his facts there is little to be said. His mind does not move freely and surely among psychological terms or theories or deductions. Reason means for him the source of all performances above the level of instinct, and his only basis of discrimination is the difference between high and low. His only theoretical problem is as to whether or not the human mind has developed from the brute mind. It will be a birthday for animal psychology when naturalists realize that this is among the least of its problems.

EDWARD THORNDIKE.

WESTERN RESERVE UNIVERSITY.

SCIENTIFIC JOURNALS AND ARTICLES.

THE December number of the *Bulletin of the American Mathematical Society* contains an account of the October meeting of the Society, by the Secretary, Professor F. N. Cole; 'Concerning a Linear Homogeneous Group in $C_{n,1}$ Variables Isomorphic to the General Linear

Homogeneous Group in m Variables,' by Dr. L. E. Dickson; 'A Second Locus Connected with a System of Coaxial Circles,' by Professor Thomas F. Holgate; 'Reciprocal Transformations of Projective Coordinates and the Theorem of Ceva and Menelaos,' by Professor Arnold Emch; 'Notes'; 'New Publications.' The January number of the *Bulletin* contains a report on the 'Theory of Projective Invariants: The Chief Contributions of a Decade,' by Professor H. S. White; 'Reye's Geometrie der Lage,' by Professor Charlotte Angas Scott; 'Burkhardt's Theory of Functions,' by Professor Maxime Bôcher; 'Darboux's Orthogonal Systems,' by Professor Edgar Odell Lovett; 'The New Mathematical Encyclopedia,' by Professor James Pierpont; 'Errata'; 'Notes'; 'New Publications.' The February number of the *Bulletin* contains an account of the Fifth Annual Meeting of the Society, by the Secretary; 'The December Meeting of the Chicago Section of the Society,' by Professor Thomas F. Holgate; 'Report on Recent Progress in the Theory of Groups of a Finite Order,' by Dr. G. A. Miller; 'Note on Burnside's Theory of Groups,' by Dr. G. A. Miller; 'On a Regular Configuration of Ten Line Pairs Conjugate as to a Quadric,' by Professor F. Morley; 'Shorter Notices,' by Professors Ernest W. Brown, Edgar Odell Lovett, J. W. A. Young, Alexander Ziwet; 'Notes'; 'New Publications.'

American Chemical Journal, March: 'On the Rearrangement of Imido-Esters,' by H. L. Wheeler and T. B. Johnson. 'On an Isomer of Potassium Ferricyanide,' by J. Locke and G. H. Edwards. By treating potassium ferricyanide with potassium chlorate and hydrochloric acid an isomer of this salt was obtained. An isomeric silver salt was also prepared and the reactions studied. In some cases the reactions of the isomers are so different that the author does not hesitate to accept this substance, which he calls potassium β -ferricyanide, as a new form. 'Reaction of Orthodiazobenzoic Acid with Sulphurous Acid and Copper Powder,' by W. E. Henderson. Experiments were carried out to test the statements so generally found in text-books that sulphonic acids are formed from the decomposition of diazo compounds by sulphurous acid in the presence

of copper powder. The results showed that, under ordinary conditions, sulphonic acids were not formed. 'Direct Nitration of the Paraffins,' by O. A. Worstell. The author finds that the results as given in his earlier paper on the action of nitric acid on the paraffins hold for all the paraffins studied. 'Higher Primary Nitroparaffins,' by R. A. Worstell. The author has continued the study of the derivatives of the higher paraffins on the line suggested by Victor Meyer in his study of the lower members of the series. 'The Action of Ethylic Oxalate on Camphor,' by J. B. and A. Tingle. 'Liquid Acetylene Diiodide,' by E. H. Keiser. A second form of the three theoretically possible ones has been obtained in liquid form. 'A Simple Color Reaction for Methyl Alcohol,' by S. P. Mulliken and H. Scudder. The alcohol is converted into formic aldehyde by plunging a hot copper wire into it. Resorcin and sulphuric acid are then added and a characteristic color reaction follows. 'Reactions for the Detection of the Nitrogroup,' by S. P. Mulliken and E. R. Barker. The first method depends on the reduction to hydroxylamine and the test for this with silver nitrate, and the second on the conversion into rosaniline. J. ELLIOTT GILPIN.

THE *Osprey*, for January, has for its first article some interesting 'Notes on *Eugenes fulgens*' by F. C. Willard, accompanied by a fine plate showing four nests. Next comes descriptions of the 'Nesting of the Alaska Bald Eagle,' by George G. Cantwell, followed by descriptions of the habits in captivity of Great Horned Owls, Barn Owls and young Short-eared Owls respectively, by M. A. Carriker, D. A. Cohen and Ludwig Kumlien. 'A Visit to Pelican Island, Indian River, Florida,' is described by L. W. Brownall, and the 'Nesting of the Black-and-White Warbler,' by J. Warren Jacobs. Other brief articles, editorials, notes and reviews complete the number.

THE leading article of the *Journal of the Boston Society of Medical Sciences* is a series of 'Observations upon the Elastic Tissue of Certain Human Arteries,' by George B. Magrath. Richard M. Pearce has a paper on 'Scarlet Fever; its Bacteriology, Gross and Minute

Anatomy,' and Horace D. Arnold one on the 'Weight of the (Normal) Heart in Adults,' the conclusion being that the average weight for males is 290 grams and for females 260 grams. The final article, 'A Study of the Encapsulated Bacilli,' by Lawrence W. Strong, finds that the gas production of these bacilli affords a valuable aid for their study and identification.

THE *Electrical World* and the *Electrical Engineer* will be issued, hereafter, as one publication, to be known as the *Electrical World and Engineer*, under the editorship of T. Commerford Martin and W. D. Weaver. W. J. Johnston, former editor of the *Electrical World*, has retired.

DR. W. P. WYNNE, F. R. S., has been elected editor of the Journal of the British Chemical Society.

SOCIETIES AND ACADEMIES.

THE ANNUAL MEETING OF THE NEW YORK ACADEMY OF SCIENCES, FEBRUARY 27, 1899.

AFTER the reading of the minutes of the last annual meeting, the reports of the officers for the year just closed were called for by the President, Professor Henry F. Osborn.

The Corresponding Secretary reported briefly that he had succeeded in correcting and revising the list of honorary and corresponding members, after a considerable amount of correspondence, and that the corrected list would be published in Part I. of the volume of Annals for 1899. The Recording Secretary then presented the following report, summarizing the progress and work of the Academy during the preceding year:

The last year of the Academy has been extremely satisfactory, and its affairs are in a much more promising condition than heretofore. Interest in our meetings has increased during the year, and the number of people cooperating in our work is much larger than ever before.

During the last fiscal year there have been thirty-one meetings of the several sections, three public lectures and one public reception. The sections now organized are those of Astronomy and Physics, Biology, Geology and Mineralogy, and of Anthropology, Psychology and Philology. The latter section has been

divided into two sub-sections, for economy of effort. Particular mention should be made of the good work and increased interest in the sub-section of Anthropology and Psychology, largely due to the personal and persistent efforts of Dr. Boas.

During the year a total of ninety-four papers has been presented before the Academy, thirty-seven new members have been elected, twelve have resigned, leaving a total of three hundred and thirty-five on the Secretary's list, including six new life members. The Fifth Annual Reception held in April last was in some ways the most successful in the history of the Academy. During the year the by-laws have been very completely revised, simplified and made workable, particularly in such a way as to give the individual sections and sectional officers more importance in the program, and so as to reduce the number of business meetings at which the Academy must be formally organized for general business to one each month. The public lectures have been more firmly established than heretofore, and have been assigned to the various sections so that each department may be popularly represented. The printed program of the year's meetings has been announced in advance, and has been found very helpful.

The publications of the Academy have been greatly improved as to quality, appearance and dignity, by the change incorporated in January last, when the Transactions were abolished. The thanks of the Academy are certainly due to our enthusiastic and very careful editor, Mr. van Ingen, for the great amount of work and care that he has put upon the publications. It is through the publications only that we are known abroad in the world, and it is very necessary that we should thus appear in the most favorable manner possible.

The Academy is in great need of more money for publication, and our efforts should be devoted as fully as possible to the securing of contributions for such work. We are continually obliged to decline valuable scientific papers by our members because of a lack of funds for printing. This is a condition of affairs which should not be allowed to continue long.

It is a great pleasure to the Academy to feel that certain of the scientific wants of the city are soon to be met, owing to the encouragement given by one of our Patrons, who has always been interested in the Academy. I refer particularly to the gift to the Scientific Alliance, of which the New York Academy of Sciences is the original member, of \$10,000 for a scientific building, donated by Mrs. Herrman. During the coming year it is hoped to bring the several sections in touch, so as to have a uniform policy of procedure, and the manner of printing the proceedings will be simplified and unified.

The report of the Treasurer showed the finances to be in a promising condition, but that the expenses too nearly equalled the income, and that endowments are very necessary if the work is to be increased as it should be.

One of the most interesting features of the meeting was the report by the Editor of the *Annals* concerning the details of his work during the last year in printing the volume just finished according to the new plan as to typography, pagination, illustration and general form, which was adopted a year ago and which has proved extremely successful and gratifying.

The last official report was a brief one by the retiring Librarian concerning the present condition of the library, which is now housed in a large room in Schermerhorn Hall, of Columbia University, and available for reference by all working scientists and members of the Academy.

The following list of honorary and corresponding members was then elected, and seventeen resident members were made Fellows because of their attainments in scientific work:

HONORARY MEMBERS.

Lord Rayleigh, M.A., D.C.L., LL.D., F.R.S., Royal Institution of Great Britain, Albemarle St., Piccadilly, N. W., London.

George Howard Darwin, M.A., F.R.S., Trinity College, Cambridge, Eng.

CORRESPONDING MEMBERS.

Dr. Louis Dollo, Musée d'Histoire Naturelle, Brussels, Belgium.

Dr. Otto Jaekel, Kgl. Museum für Naturkunde, Invalidenstr. 43, Berlin.

Professor Dr. Eberhard Fraas, Kgl. Naturalien Kabinet, Stuttgart, Germany.

Professor Dr. Charles Depéret, Faculté des Sciences, Lyons, France.

Dr. C. W. Andrews, British Museum of Natural History, London, England.

Dr. Max Schlosser, Palaeontologische Sammlung des Staates, Alte Akademie, Munich, Germany.

G. H. Boulenger, British Museum, London, England.

Professor G. B. Howe, Normal College of Science, S. Kensington, London, England.

Dr. Walter Innes, School of Medicine, Cairo, Egypt.

Dr. A. Liversidge, Sydney, New South Wales.

Professor Mansfield Merriman, Lehigh University, South Bethlehem, Pa.

Dr. Stuart Weller, University of Chicago, Chicago, Ill.

Professor Ludwig Boltzmann, University of Vienna, Vienna, Austria.

Professor P. LaCroix, Musée d'Histoire Naturelle, Paris, France.

Dr. A. Smith Woodward, British Museum of Natural History, London.

Professor Dr. Friedl. Kohlrausch, Physikalisch Technische Reichsanstalt, Charlottenberg, Marshstrasse 25, Berlin.

Professor R. H. Traquair, Museum of Science and Art, Edinburgh, Scotland.

Professor W. C. Brögger, Christiania, Norway.

J. G. Baker, Royal Gardens, Kew.

Professor Wilhelm Ostwald, University of Leipzig, Leipzig, Germany.

The list of officers given below was then elected by ballot:

President, Henry F. Osborn.

1st Vice-President, James F. Kemp.

2d Vice-President, Chas. L. Bristol.

Corresponding Secretary, William Stratford.

Recording Secretary, Richard E. Dodge.

Treasurer, Charles F. Cox.

Librarian, Bashford Dean.

Councillors, Franz Boas, Charles A. Doremus, William Hallock, Harold Jacoby, Lawrence A. McLouth, L. M. Underwood.

Curators, Harrison G. Dyar, Alexis A. Julien, George F. Kunz, Louis H. Laudy, William D. Schoonmaker.

Finance Committee, Henry Dudley, John H. Hinton, Cornelius Van Brunt.

The formal work of the evening was followed by the annual address of the President. Professor Osborn took for his title 'The Succession of Mammalian Fauna in America, compared with that in Europe during the Tertiary Period.'

The formal meeting was followed by refreshments and a social gathering, which lasted until a relatively late hour.

RICHARD E. DODGE,
Recording Secretary.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 497th meeting of the Society was held on March 4th, at 8 p. m., in the assembly room of the Cosmos Club. The first paper was by Professor F. H. Bigelow on 'The Influence of Electricity on Vegetation.' It was stated that vegetation under the Aurora belt shows remarkable developments, due not to the length of the summer day, but to the electric currents. Experiments indicate that static electricity, supplied by machines, when applied to plants increases their growth about 40 per cent. Extensive trials in many places and under different conditions generally confirmed this result.

The second paper was by Surgeon-General Sternberg on 'Some Sanitary Lessons of the Late War.' An abstract of this very interesting and instructive address has not yet come to hand.

E. D. PRESTON,
Secretary.

GEOLOGICAL SOCIETY OF WASHINGTON.

At the 89th meeting of this Society, held in Washington, D. C., on March 8, 1899, Mr. Arnold Hague, U. S. Geological Survey, exhibited a geological relief map of the Yellowstone Park and of the Absaroka Range, in northwestern Wyoming, showing some of the physical features of the latter region by means of lantern illustrations. The map is constructed on the scale of one mile to an inch, the area represented being approximately 75 miles square. The base of the model is taken at 5,000 feet above sea level, from which rise several dominating peaks showing elevations of over 12,000 feet above sea level. It requires about forty distinct colors to represent the different geological formations into which the sedimentary and igneous rocks have been divided. All the geysers and hot springs areas are delineated, together with the regions of extinct hydro-thermal action. In the model a sharp contrast between the rhyolite plateau of Yellowstone Park of

Pliocene age and that of the eroded and dissected plateau of the Absarokas of Miocene age is clearly brought out. Mr. Hague stated that he hoped the map would be sent to the Paris Exposition next year. The lantern slides were selected to illustrate the manner in which the Absarokas were built up by the gradual accumulation of breccias, agglomerates and basalt flows, forced upwards from numerous fissures and vents during a long period of time, and the elevation of the range by the intrusion of powerful stocks of gabbro, syenite, diorite, diorite-porphry and granite-porphry. The character of the different breccias, the incisive trenching of the deep canyons, and the stocks, together with their associated sheets and network of dikes, were discussed.

Mr. F. B. Weeks, U. S. Geological Survey, gave some observations made last summer in the course of a reconnaissance in Jackson Basin, northwest Wyoming.

The Jackson Basin, he said, occupies a depression within the Rocky Mountains, of Wyoming, of 5 to 8 miles in width and 45 miles in length. The Teton range forms a lofty, precipitous barrier along its western side. The valley has an elevation of 6,200 to 6,800 feet, and the Tetons rise 7,000 feet above it. The Tetons are noted for their wonderful Alpine scenery. Jackson Lake and several smaller lakes occur within the valley—all of glacial origin. The northeastern portion of the basin is covered with numerous morainal ridges and hillocks. The eastern side is buried beneath a great mass of material brought down by glacial streams. They have the forms of huge deltas, spreading out from the foothills in fan-shaped areas, several miles long and as many miles in width where they reach the Snake River. Along some of the main streams terracing has been well developed. The streams flowing over these deltas follow well defined courses, but have a tendency to spread laterally instead of widening and deepening their beds. The Upper and Lower Gros Ventre buttes are prominent outliers of the Gros Ventre range. They are formed, in large part, of Paleozoic rocks, and are probably directly connected with the main range. The heavy mantle of debris makes it impossible to trace a definite connection.

The meeting closed with some remarks by Mr. W. Lindgren, U. S. Geological Survey, on the Boise Folio (No. 45, of the Geol. Surv.), recently published.

WM. F. MORSELL.

DISCUSSION AND CORRESPONDENCE.

ON THE MAKING OF SOLUTIONS.

TO THE EDITOR OF SCIENCE: A remark in a recent paper by Professor Macloskie calls my attention afresh to a curious error which, so far as I know, is universally current in our zoological laboratories. Professor Macloskie remarks (SCIENCE, Vol. IX., p. 206) "a 1% solution of cane sugar in water, * * * that is 342 grams, * * * dissolved in 34,200 grams of water." In other words, a 1% solution is made by mixing 1 part of the substance to be dissolved with 100 parts of the solvent. In this conception the zoologists appear to be at one. It is sufficient to refer to any of the well-known text-books: Marshall and Hurst, 'Practical Zoology,' 4th ed., p. 464; Gage, 'The Microscope,' 6th ed., p. 179; Dodge, 'Elementary Practical Biology,' p. 391. Like many other text-books, Huxley and Martin's 'Practical Biology' (revised ed., p. 496), does not directly commit itself to the error, but gives directions to make the 'normal saline solution' by mixing 7.5 grams of salt with a liter of water. That the normal saline solution is a $\frac{1}{100}$ solution is directly stated by Whitman ('Methods of Research,' etc., edition of 1885, p. 207), and Lee (The Microtome, 4th ed., p. 263.),

These citations abundantly prove that Professor Macloskie's conception of a 1% solution corresponds with that of other zoologists. If, however, we ask a chemist how such a solution is made, the reply will be: "Dissolve one part of salt, sugar, or whatever the substance may be, in *ninety-nine* parts of the solvent." And that this is logically correct becomes self-evident upon a moment's thought. A 1% solution of HCl, as all will agree, consists of one part of the acid to ninety-nine parts of water. Why should the fact that in one case we deal with a solid, in the other with a liquid, alter the case?

It would seem that unless, or until the zoologists come into agreement with the chemists,

every investigator in publishing his researches should make a point of preventing ambiguity by stating whether his 1%, 5%, 20% solutions of solids are compounded on the logical or the zoological plan.

M. A. WILLCOX.

WELLESLEY COLLEGE, March 6, 1899.

THE ORIGIN OF NIGHTMARE.

OVER and over again when a child I was for years the victim at night of a certain form of mild nightmare, so that it came to be to my fearful imagination no insignificant part of my unpleasant experiences. This nightmare always took the form of a great wave of something gradually rolling towards me and finally engulfing and oppressing me to a painful extent. It would roll up a huge shapeless mass of no particular material, but always irresistibly towards me helpless and overwhelmed. Most often it finally appeared to be a huge soft pillow or even formless feather bed, but without color or other qualities save that of engulfing and terrifying. At its worst on various occasions this mass as it rolled up became a huge fat boar, defined as such, however, only subconsciously, but always dreadful in its power to overwhelm me. All this was years ago.

One night recently, as I was falling asleep in bed in a lighted room, I became gradually aware of that sensation which compression of a nerve produces, a vague and quite indefinite sense of discomfort localized only in the region about my head and arms, but in my state of somnolence only a growing sensation of discomfort pressing on my consciousness. Increasing steadily, it finally began to awaken me, and I then became distinctly conscious of the well-remembered nightmare of my childhood beginning to approach. With the noise in the room I was now sufficiently awake to be interested in this familiar visitor, and I lay still deliberately. Gradually the mass rolled up towards me exactly as of yore, with no terror in its coming now, until finally it was upon me and all about me oppressively. I very slightly moved my arm (upon which my head was lying), and the nightmare was for the moment lost sight of in the sensations now localized there. I opened my eyes and instantly the whole experience vanished, closed them and it instantly returned

in all its force and peculiarities. Over and over again this little experiment was performed without variation in its results, until, finally, satisfied, I moved my head off my arm and stretched my arm out of its cramped position, and felt no more this *bête noir* of earlier days, now again returned, bringing with it emphatic and unmistakable explanation of its cause.

G. V. D.

ASTRONOMICAL NOTES.

A NEW SATELLITE OF SATURN.

A new satellite of the planet Saturn has been discovered by Professor William H. Pickering at the Harvard College Observatory. This satellite is three and a half times as distant from Saturn as Iapetus, the outermost satellite hitherto known. The period is about seventeen months, and the magnitude fifteen and a half. The satellite appears upon four plates taken at the Arequipa Station with the Bruce Photographic Telescope. The last discovery among the satellites of Saturn was made half a century ago, in September, 1848, by Professor George P. Bond, at that time Director of the Harvard College Observatory.

EDWARD C. PICKERING.

HARVARD COLLEGE OBSERVATORY,
CAMBRIDGE, MASS., March 17, 1899.

NOTES ON PHYSICS.

THE NERNST LAMP.

THE electric lamp recently invented by Nernst, as has been stated in this JOURNAL, consists of a small rod of magnesia which is heated to brilliant incandescence by an electric current which is pushed through it by an electromotive force of several hundreds of volts. The rod must be heated nearly to a red heat by a blow-pipe or other independent means before it passes sufficient current to operate.

A number of these lamps have been made in the Physical Laboratory at Bethlehem, Pa. It has been found that a rod of pure magnesia can scarcely be started even with 1,000 volts and a good blow pipe. The surrounding air becomes electrically too weak to withstand the high electromotive force at a temperature lower than

that required to make the rod a sufficiently good conductor. This is true even when the rod has been heated to softness beforehand in a temporary mounting.

The conductivity of the rod may be completely controlled by mixing with the magnesia varying amounts of silica and of fusible silicates. A satisfactory lamp is made as follows: Pure calcined magnesia (heavy) is thoroughly mixed with two or three per cent. of powdered silica, one or two per cent. of magnesium sulphate, and one per cent. or less of sodium or potassium silicate (water glass). The mixture is dried until it is just moist enough to pack under pressure. A small piece of brass tubing is lined with a roll of several thicknesses of stiff writing paper, and the mixture is tamped into this tube. The tube is then baked until the paper is burned, when the rod of magnesia may be removed. This rod is then laid upon a bed of magnesia (powdered lime would, perhaps, answer) and by means of carbon terminals an alternating current is passed through the rod, heating it first to redness by a blow pipe. With some care a very hard and compact rod of magnesia is thus formed which is then ground to a thin rod with large grooved ends. Platinum wire is wound on these grooved ends and, if desired, cement made of water glass and powdered magnesia may be used to cover the platinum. The two platinum wire terminals may then be bound to the sides of a small glass tube as a support. A lamp made in this way may be started easily, although its resistance rises slowly with continued use, owing, perhaps, to the volatilization of the potassium or sodium silicate. Calcium silicate would, perhaps, be more satisfactory in this respect.

A very striking experiment may be performed with a piece of glass tubing several inches long wound with copper terminals at its ends. The tube begins to pass considerable current at a low red heat, with a few hundreds of volts, and is quickly melted by the current. A thin-walled tube half an inch or more in diameter is best, and it should be heated along one side only so that the cool portion of the tube may for a short time serve as a support for the hot conductive portion.

W. S. F.

PYROELECTRICITY AND PIEZOELECTRICITY.

W. VOIGT (*Wiedemann's Annalen*, No. 13, 1898) shows that the electrification of certain crystals by heating (pyroelectricity) and the electrification by deformation (piëzoelectricity) are in general one and the same phenomenon, and that it is only in such a crystal as tourmalin, which has a single axis distinguished from all other axes by characteristic physical properties, that pyroelectricity is not due wholly to the deformation accompanying a rise of temperature. Professor Voigt also points out that a plate of tourmalin can be used to generate accurately known electric charges by subjecting it to measured compression, and he gives the results of a determination of an electrostatic capacity based upon the known charge generated by a tourmalin plate and the known e. m. f. of a standard cell.

W. S. F.

THE ROTARY CONVERTER.

IN two short articles in the *Electrical World*, for December 17th and 24th, Mr. C. P. Steinmetz gives a quite complete discussion of the theory and action of the rotary converter, a machine used to convert alternating current into direct current, mainly in connection with long distance transmission. Mr. Steinmetz's papers are, almost without exception, very difficult to read for the reason, chiefly, that he always gives a great deal of precise information about difficult subjects not generally understood. The present paper cannot, of course, be abstracted, but it is mentioned for the reason that Mr. Steinmetz deserves to be more generally known as one of the foremost electricians of our time; that he is a scientific electrician is a matter of course.

W. S. F.

THE TELESCOPE-MIRROR-SCALE METHOD.*

PROFESSOR S. W. HOLMAN has given in the *Technology Quarterly*, for September, 1898, a most complete and usable discussion of the telescope-mirror-scale method for measuring angular deflections. Almost at the very beginning of the paper a list of the fourteen instrumental errors is given, together with directions for making the adjustments which are necessary

*Published separately by John Wiley & Sons, New York. Price, 75 cents.

to reduce each error to a prescribed value. Following this is a general discussion of each error of adjustment and a derivation of the error in angle due to each. Most physicists have, of course, looked into the detailed theory of the telescope-mirror-scale method in spite of the fact that the literature on the subject is not generally accessible, but the habitual use of the method for rough measurements makes one lose sight of a dozen or more of the adjustments and precautions which are necessary in accurate work, and, therefore, almost every physicist will find this pamphlet of Professor Holman's a useful reminder when the need arises to use the method with all the precision it is capable of.

W. S. F.

NOTES ON INORGANIC CHEMISTRY.

SOME time ago a committee was appointed by the German Chemical Society to formulate an atomic-weight table which should serve as a basis for practical use in analytical calculations. This committee consisted of Professors Landolt, Ostwald and Seubert, and has recently brought in a report which has been widely published. With three exceptions, the decimals in the atomic weights are given only as far as the last figure is practically correct. The weights as far as given agree in general with those published by Professor F. W. Clarke. The most interesting point in connection with the table is that the basis used is the atomic weight of oxygen = 16. It is now a number of years since Dr. F. P. Venable and others in this country and abroad uttered strong protests against the use of hydrogen = 1 as a standard, especially since the atomic weights with few exceptions are determined with reference to oxygen, and at that time the ratio between hydrogen and oxygen was uncertain. Now that this ratio has been, thanks to Professor Morley, rendered almost certain to three decimal places, it is still unnecessary and unscientific to bring in even this little uncertainty, which in the elements of high atomic weight amounts to quite an appreciable quantity. Professor Seubert has been one of the strongest advocates of the basis $H = 1$, and it is noteworthy that he has agreed to the committee report. In the report Seubert says that, while $H = 1$ is in

principle the most correct and natural, he agrees to the report chiefly because with $O = 16$ many of the weights most frequently used in calculations are represented by whole numbers, and hence these numbers are most conveniently used. Landolt adds that he hopes this report will lead to an international agreement as to the figures used.

In a recent paper in the *Journal für praktische Chemie*, W. Eidmann describes the action of metallic magnesium upon compounds containing nitrogen, especially upon the cyanids. At a red heat almost all compounds, inorganic and organic, which contain nitrogen are decomposed, generally with the formation of magnesium nitrid, Mg_3N_2 . The cyanids of the alkalies and alkaline earths are decomposed without explosion, the carbide of the metal being formed. This, Eidmann says, shows that the ordinarily accepted formula of the cyanids, *e. g.*, $Ba \begin{smallmatrix} C \equiv N \\ C \equiv N \end{smallmatrix}$ is correct. In the case of those cyanids which decompose at a red heat, as those of zinc, nickel, lead, copper, etc., the reaction with magnesium is more violent and decomposition into magnesium nitrid, carbon and the metal ensues. In the case of those cyanids, as those of silver and mercury, which decompose below a red heat the liberated cyanogen reacts with magnesium with explosive violence.

A SERIES of analyses of waters from wells near the sea-shore are published by P. Guichard in the *Bulletin Société Chimique*. The water in these wells rises and falls with the tide, while the composition of the water leads to the conclusion that there is no direct connection between the wells and the sea, and, hence, it follows, according to the author, that subterranean waters must be affected by the moon, even as the ocean. This conclusion will, doubtless, find many to dissent from it.

A DESCRIPTION is given in the *Pharmaceutische Zeitung* by Alfred Zucker of the manufacture of whitelead by electrolysis, at Dellbrück, according to the Luckow process. The electrolyte is a 1½% solution of 80% sodium chlorid and 20% sodium carbonate. The anode is soft lead, the kathode hard lead. The current is 0.5 ampère per square centimeter at

2 volts. Water and carbon dioxide are carefully added as the electrolysis proceeds. With care as to the strength of the electrolyte, a purity of whitelead is obtained not hitherto reached. The hygienic regulations of the factory are worthy of mention. Every operative receives daily one liter of fresh milk, and at the conclusion of his daily work must clean very thoroughly his hands, finger nails, etc. In addition he receives Glauber's salts, and every fortnight must take a complete warm bath in water which contains a certain amount of liver of sulfur. By these precautions all cases of saturnine poisoning have been avoided for several years.

ALTHOUGH not under the head of inorganic chemistry, mention may be permitted of a description of the manufacture of artificial silk in a recent number of the *Zeitschrift für Angewandte Chemie* from the pen of H. Wyss-Naef. The first practical use of the process was in 1889. The raw material is carded cotton which is first converted into nitrocellulose by a bath of strong nitric and sulfuric acids. After washing and drying it is dissolved in a mixture of alcohol and ether. This collodion is then spun through openings .08 mm. diameter. The alcohol and ether evaporate almost instantly on spinning and the material is carefully dried. It is then treated by a secret process to reduce the nitro groups, ammonium sulfid being probably the reducing agent used. The silk is then bleached with chlorin and is ready for the market.

J. L. H.

CURRENT NOTES ON METEOROLOGY.

THE THEORY OF CYCLONES AND ANTICYCLONES.

A PUBLICATION of unusual interest, containing conclusions of the greatest importance in meteorology, has been issued as *Bulletin* No. 1 (1899), of the Blue Hill Meteorological Observatory ('Studies of Cyclonic and Anticyclonic Phenomena with Kites,' by H. Helm Clayton). This is a study of the results obtained during the kite flights of September 21st-24th and of November 24th-25th last, and it will aid materially towards once more strengthening belief in the older Ferrel, or *convective* theory of cyclones and anticyclones, as opposed to the newer Hann, or *driven* theory. Lack of space

prevents mention of many of the striking facts set forth in this *Bulletin*. The flights of September 21st-24th brought down records from altitudes of 2,000 to 3,400 meters, in a well-marked anticyclone, and in a succeeding cyclone which followed the same track. The temperature near the center of the anticyclone was the same at 2,100 meters as at 1,200 meters, and the humidity at the greater altitudes was excessively low. These results agree with those previously found in similar conditions. The axis of the anticyclone was inclined backwards, the high pressure occurring later at high than at low levels. Up to 3,000 meters the temperature of the air was higher on the day of the cyclone than on the day of the anticyclone—a normal condition at Blue Hill, as previous kite ascents have shown. A further notable discovery is that cyclonic and anticyclonic circulations observed at the earth's surface in this latitude do not seem to embrace any air movement at greater altitudes than 2,000 meters, except in front of cyclones. Above 2,000 meters there seem to be other poorly developed cyclones and anticyclones, with their centers at entirely different places from those on the earth's surface, and with different wind circulations.

On November 24th-25th the kite meteorograph was sent up near the center of a cyclone and in a succeeding anticyclone. From sea-level to 2,800 meters the temperature was 13°-24° F. higher on the day of the cyclone (November 24th) than on the following day. The results of the observations on November 24th-25th also go to show that when the cold in the rear of a surface cyclone is exceptionally severe, the axis of the cyclone is inclined backward so sharply that the circulation breaks into two or more systems. Thus there come to exist a surface cyclone, a mid-air cyclone and an upper-air cyclone. On November 25th, at 3,000 meters, there existed a cold-center cyclone, in which the air had a descending component of motion, as indicated by the low humidity.

The results of the careful study made by Mr. Clayton lead him to the view that the *convective* theory of cyclones is the true one. This *Bulletin* again bears evidence to the admirable work which is being done by the staff of the

Blue Hill Observatory, and to the important contributions which Mr. Clayton and his assistants, with Mr. Rotch's liberal support, have made to meteorology.

CARBONIC ACID IN DEATH GULCH.

THE amount of carbonic acid in the atmosphere, which, under ordinary conditions, averages about 0.03%, may, in exceptional circumstances, attain a considerably higher percentage. In certain volcanic districts the amount of carbonic acid may be large enough to cause the death of animals which stray into the hollows where, owing to its density, the gas collects. The Grotto del Cane, near Naples, is a region of this sort. Another is Death Gulch, in the Yellowstone National Park. In an account of a recent trip in the Park, in *Appleton's Popular Science Monthly* for February, Jaggard reports his discovery, in Death Gulch, of the carcasses of eight bears, all of which had doubtless been asphyxiated by the excessive amount of carbonic acid in the air.

R. DEC. WARD.

HARVARD UNIVERSITY.

ZOOLOGICAL NOTES.

NEOMYLODON LISTAI.

DR. EINAR LÖNNBERG describes at length* some portions of skin found in a cave at Eberhardt, near Last Hope Inlet, 51° 35' S., 72° 38' W., in the Territorio de Magallanes, Chile, and obtained by the Swedish expedition which visited Tierra del Fuego in 1896. The cave, located a few kilometers from the coast and about 500 feet above sea-level, was about 600 feet deep and 150 feet wide at the entrance. It was discovered by some farm laborers, who promptly destroyed the human skeletons found in the cave, although they fortunately preserved some pieces of thick, strange-looking skin, and the sheath of a claw found partly imbedded in the stalagmitic deposit of the floor. The claw and two pieces of skin were secured by Nordenskjöld; the smaller piece measured about 7 × 15 cm.; the larger, irregular in shape, 50 × 76 cm., is believed to be from the left fore leg. The small

* Reprint from *Wissenschaftl. Ergebnisse Schwedischen Expedition nach den Magellansländern unter Leitung von Otto Nordenskjöld*.

fragment of skin is 1 cm. thick covered, externally with coarse, dirty yellowish hair, and internally so thickly set with rounded ossicles as to suggest a cobblestone pavement. The inner surface of the larger piece does not show any ossicles, but in the freshly-cut margin they are apparent, although small and completely imbedded in the skin; the hair on this fragment is from 5 to 9 cm. long. Under the microscope a transverse section of this hair is seen to be solid, lacking the central pith usually present, and on comparison with the hairs of various South American edentates its greatest likeness is found in the central axis of the hair of *Bradypus*. The microscopical structure of the ossicles, which is described at length by Dr. Lönnberg, is strikingly like that of the ossicles of the true fossil *Myiodon*. The claw, 104 mm. long by 34 wide, is considered to belong to *Neomyiodon*, as there is no existing South American mammal provided with similar claws, and is believed to have belonged on a hind foot. The animal is estimated to have been at least 6 feet long and 4 feet or so high at the shoulder. After a careful consideration Dr. Lönnberg comes to the conclusion that, while *Neomyiodon* was contemporaneous with early man and was used as food, it certainly does not exist at present, because it is absolutely impossible for it to have eluded the sharp eyes of the native Indians; neither is it identical with the animal that Ramon Listai is said to have shot at. It will be noted that the conditions under which the skin was preserved are very similar to those which led to the preservation of portions of the skin and feathers of *Dindornis*.

F. A. L.

SCIENTIFIC NOTES AND NEWS.

THE Second International Conference on a Catalogue of Scientific Literature requested the delegates from the countries represented to take steps for the formation of committees to study the various questions relating to the Catalogue, and for the United States the following committee has been named: Dr. J. S. Billings, Professor Simon Newcomb, Dr. Theodore N. Gill, Professor H. P. Bowditch, Dr. Robert Fletcher, Mr. Clement W. Andrews and Dr. Cyrus Adler. Different universities and scien-

tific societies have been invited to form committees to report upon the questions involved.

THE appointment of Mr. Herbert Putnam as Librarian of the National Library will be welcomed by all friends of science and learning. It is well known that Mr. Putnam has excellently administered the Public Library of Minneapolis and the Boston Public Library, and will undoubtedly make the National Library what he has himself said it should be, "the foremost library in the United States, a national library, the largest in the United States, a model and example of assisting the work of scholarship in the United States." Men of science are directly interested in this appointment, as the great collection of scientific books of the Smithsonian Institution is deposited in the Library.

DR. THOMAS J. SEE, recently appointed professor of mathematics in the Naval Observatory, has been designated as Chief of the Nautical Almanac.

PROFESSOR PATRICK GEDDES, of Edinburgh, is at present visiting the United States with a view to sociological and other studies. Professor Geddes is well known for his accomplishments and versatility in biological science and for his efforts to improve sociological conditions in Edinburgh.

MR. G. F. STOUT, recently appointed Wilde lecturer on mental philosophy at Oxford, and Mr. Charles Stewart, Curator of the Museum of the Royal College of Surgeons, London, have been given the degree of LL.D. by the University of Aberdeen.

THE Stockholm Society for Geology and Geography has awarded its Vega medal to Professor Georg Schweinfurth, of Berlin.

THE Leopoldinisch-Carolinische Deutsche Akademie der Naturforscher, of Halle, has awarded the Cothenius gold medal to Dr. F. Zirkel, professor of mineralogy in the University of Leipzig.

PROFESSOR A. H. SAYCE, of Oxford University, has been appointed Gifford lecturer in Aberdeen University for 1900-1902.

PROFESSOR BURDON SAUNDERSON gave the Croonian lecture before the Royal Society on

March 16th, on 'The Electric Concomitants of Motion in Animals and Plants.'

PROFESSOR JEBB, of Cambridge, will deliver the Romanes lecture at Oxford, June 7th, his subject being 'Humanism and Education.'

THE following Friday evening discourses are being given before the Royal Institution, London: March 10th, 'Measuring Extreme Temperatures,' by Professor H. L. Callendar, F.R.S.; March 17th, 'The Electric Fish of the Nile,' by Professor Francis Gotch, F.R.S.; and on March 24th, 'Transparency and Opacity,' by Lord Rayleigh, F.R.S.

PROFESSOR C. C. GEORGESON, of the Department of Agriculture, has left Washington for Sitka to superintend investigations in experimental agriculture. A building will be erected at Sitka this year which will contain offices for the experiment station and for meteorological observations.

THE Lord Mayor of Liverpool entertained, on March 4th, Professor Oliver J. Lodge, in recognition of his having received the Rumford medal, which is awarded biennially by the Royal Society for the most important discoveries in heat or light. Speeches were made by the Lord Mayor; Professor Fitzgerald, of Dublin; Sir John Brunner; Professor Myers, of Cambridge; Professor Rücker and Sir W. Crookes. It was announced at the dinner that Sir John Brunner had offered £5,000 towards a new building for the physical laboratory for University College, Liverpool, which is under Professor Lodge's direction.

A STATUE in bronze of the late Dr. William Pepper, of Philadelphia, will be erected in the plaza before the City Hall.

PROFESSOR JOHN COLLETT, for many years State Geologist of Indiana, died at Indianapolis, on March 15th, aged 71 years.

DR. W. HANKEL, professor of physics in the University of Leipzig, died on February 18th, at the age of 84 years.

DR. FRANCIS M. MACNAMARA died on March 5th, at the age of 57. He was formerly professor of chemistry at the Calcutta Medical College and chemical examiner to the Governor of India, where he made important investigations

on the spread of cholera by water and on the distribution of disease.

CONGRESS, in its closing hours, passed a bill containing the stipulation, "That before January 1, 1903, the fence around the Botanical Garden shall be removed, provided that at the first session of the Fifty-sixth Congress the Joint Committee on Library is directed to report a bill embodying a plan for removing the Botanical Garden to another location." The Botanical Garden in Washington has done little for science, being administered by a Joint Committee on the Library of Congress. It is proposed to remove the Garden to a place where a larger area can be secured, and establish there a National Botanical Garden, which will probably be placed under the charge of the Department of Agriculture.

THE New York City Board of Estimate and Apportionment authorized, on March 17th, an issue of bonds to the amount of \$500,000, the proceeds to be used in defraying the cost of removing the Forty-second street reservoir and in laying the foundations for the building for the New York Public Library, Astor, Lenox and Tilden foundations. Mayor Van Wyck is reported to have said: "The original request was for \$150,000. We looked the matter over carefully and concluded that such a sum would suffice only for the demolition of the reservoir. It was suggested that the first requisition for bonds under the act authorizing the construction of the library be large enough to cover the cost of the foundations for the structure. The trustees of the library agreed to this, and the plans were accordingly amended. With \$500,000 it will be possible within nine or ten months to raze the reservoir and lay the foundations. Then we shall be ready to order another issue of bonds and to prosecute the work to an early completion." The New York City Board of Estimate and Apportionment has also set aside \$63,000 for work on the Zoological Garden in Bronx Park.

MAYOR VAN WYCK has given a public hearing on the bill passed by the Legislature authorizing the Board of Estimate and Apportionment to increase the annual appropriation for the American Museum of Natural History from

\$90,000 to \$130,000. Professor Albert S. Bickmore, representing the Museum, and Senator Plunkitt, the introducer of the bill, declared that, on account of recent additions to the building, more money was required for its maintenance, the present allowance being inadequate. The Mayor did not publicly declare his intentions towards the bill, but it is believed that he will sign it.

THE Joint Committee of the Royal Society and the Royal Geographical Society, appointed to promote a National Antarctic Expedition, made application some time ago to the Council of the Royal Society and the Council of the British Association for grants of money in aid of the proposed expedition. The Treasurer of the Royal Society has applied, on behalf of the Council, to the Government Grant Committee for a grant of £1,000, and the Council of the British Association will recommend to the next meeting of the General Committee that a like sum be contributed by the Association. The scientific societies in Australia are moving in the matter with a view to influencing the Premiers of the different colonies.

THE Navy Department expects to make a hydrographic survey of the Philippines. The *Vixen*, now on its way to Manila, will begin the work as soon as it can be spared, and it is expected that the *Yosemite*, after making surveys about Guam, will proceed to the Philippines for this purpose.

DR. W. H. FURNESS and Dr. H. M. Miller have returned from an expedition to Florida, where they have been collecting fossils for the Wistar Institute of Anatomy, University of Pennsylvania. They have made collections from the limestone quarries and phosphate mines, where Dr. Leidy secured many valuable specimens.

THE will of the late Herbert Stewart gives \$2,000 to the American Society of Engineers for a library fund and \$500 to the Engineers' Club of New York City towards its building fund. The residue of the estate, subject to life annuities, is left to the Sheffield Scientific School of Yale University for Scholarships. The amount is estimated at \$40,000.

A CIVIL SERVICE COMMISSION examination

will be held on April 11 and 12, 1899, for the position of Soil Chemist, Division of Soils, Department of Agriculture, at a salary of \$1,400 per annum. The subjects and weights are as follows:

Physical chemistry.....	20
Inorganic chemistry.....	20
Organic chemistry.....	20
Analytical methods.....	20
Literature of soils.....	10
French and German.....	10
Total.....	100

ON the same days an examination will be held for the position of Special Crop Culturist (Department of Agriculture). The subjects will be weighted as follows:

Basis examination (first grade).....	10
English composition and general training and experience.....	10
Agriculture and horticulture (general principles and practice of agriculture and horticulture, including crop rotation, selection and breeding of variety, agricultural Chemistry, fertilizers, treatment of plant diseases and insect pests).....	20
French (translation into English of a selection relating to the cultivation of field crops).....	10
Field crops (treatment of miscellaneous and little known field crops, including import statistics).....	30
Proof reading.....	10
Typewriting (tabulating, copying and spacing, and writing from dictation).....	10
Total.....	100

WE have already called attention to the Volta commemoration to be held at Como during May of the present year. Como has appropriated \$100,000 for the preliminary expenses. An electrical exhibition will be opened on May 14th. A congress of electricians will also be held.

THE eleventh annual meeting of the Botanical Society of the University of Pennsylvania was held this week, and the following officers were elected: President, *ex-officio*, Provost C. C. Harrison; acting President, Dr. Adolph Miller; First Vice-President, Mrs. L. R. Fox; Secretary, Professor J. MacFarland; Treasurer, E. C. Beane.

WE learn from the *British Medical Journal* that the French Medical Press Association held

its forty-third meeting on February 3d, under the presidency of Dr. Gézilly. It was decided to organize an International Congress of the Medical Press, to be held in Paris in 1900, at the same time as the other congresses which are to take place there in that year.

THE beginning of an arboretum will be made at the University of Michigan this year, under the direction of the pharmacy department. The plan is to have specimens of as many different kind of trees growing on the University campus as will thrive in the latitude. Special attention, however, will be given to the securing of trees of medicinal or economic importance. A few trees will be set out each year, being selected and planted by the members of the graduating classes of the pharmacy department.

THE report of the committee appointed by the Council of the Society of Arts to inquire into the requisite conditions of safety in acetylene gas generators, and to report on the various apparatus shown at the exhibition held at the Imperial Institute, says the *London Times*, has just been issued. The object of the exhibition, which was undertaken with the approval of Sir Vivian Majendie of the Home Office, and of the London County Council, was to familiarize the public with the means of generating acetylene gas, and with the simple precautions with which its use at low pressures is as safe as that of coal gas. The committee, feeling that in the interests of the public it was advisable carefully to test the various forms of generators exhibited, appointed Professor Vivian B. Lewes and Mr. Boverton Redwood as a sub-committee to make a series of tests. As a result of these tests the committee have advised the granting of certificates to those generators which have complied with the requirements of the various tests to which they have been submitted, and which have worked safely and satisfactorily during a month's every-day use. The committee classified the generators into three groups: (1) those in which the gas is generated by water being allowed to drip or flow on to the carbide; (2) those in which the water is allowed to rise in contact with the carbide, the rise being regulated by the increase of pressure in the generating chamber;

(3) those in which the carbide drops into the water. These are again subdivided into automatic generators whose storage capacity is less than the total volume which the charge of carbide is capable of generating, and which, therefore, require automatic regulation; and non-automatic, whose holders can receive all the gas produced by the charge of carbide. The committee consider that the tests have clearly demonstrated that many types of acetylene gas apparatus can be so constructed as with ordinary precautions to be absolutely safe, and that lighting by acetylene need be no more fraught with danger than any other form of artificial lighting in general use. The committee, however, feel it their duty to state that, safe as they consider acetylene gas to be, when generated in a properly-constructed apparatus outside the building to be lighted, and in accordance with the rules and suggestions contained in the report, they consider the generation of gas within the house, and the use of hand lamps, cycle lamps, etc., to be not unattended by danger, except in skilled hands. As to the storage of the carbide, the Home Office regulations allow 5lb. to be kept without a license in 1lb. packages. The committee recommend that the quantity, however small, should always be kept in a dry place, and under lock and key. These precautions, they think, may not be necessary when its properties are fully understood, as it is no more dangerous than many other substances in daily use.

THE Reale Istituto Lombardo announces in its *Rendiconti* the award of its prizes which are quoted in *Nature* as follows: The Cagnola prize of 2,500 lire and a gold medal of 500 lire has been awarded to Signor Angelo Battelli and Signor Annibale Stefanini for their joint paper containing a critical exposition of electric dissociation considered principally in regard to the experimental proofs of its deductions. For the Kramer prize, on an essay relating to the use of condensers in the transmission of electric energy by alternating currents and their construction for industrial purposes, two competitors entered, and prizes of 2,500 lire and 1,500 lire respectively have been awarded to Professor Luigi Lombardi, of Turin, and Signor Giovanni Battista Folco,

director of the electric tramways of Leghorn. For the Fossati prize, on some physiological point connected with the human encephalus, two competitors entered, and awards of 400 lire have been made to both—namely, Dr. Domenico Mirto, of Palermo, and Dr. Carlo Martinotti, of Turin. For the Brambilla prize, given for the invention or introduction of some new machine or industrial process of real practical value, seven competitors entered. A gold medal and 500 lire has been awarded to Fratelli Boltri, of Milan, for their grain desiccators; a similar award to Premoli and Zanoncelli, of Lodi, for their preparation of Gaertnerised milk. Gold medals and 200 lire have also been given to Rossi, Enrico and Co., of Milan, for their manufacture of varnishes, etc.; to Piola Alfredo, of Milan, for artists' colors; and to Pizonni Pietro, of Milan, for the manufacture of baskets. The prizes offered for future competition include prizes of the Institution for 1899 for a list of unusual meteorological events that have been recorded from the earliest times, and for 1900 for an essay on collective property in Italy; two triennial medals for improvements in agricultural or industrial processes in Lombardy; a Cagnola prize and gold medal on the subjects chosen by the Institution, viz., in 1899, for an essay on Hertz's phenomenon, or the effect of active radiation or of products of combustion on the sparking distance in air, and in 1900 for a critical study of toxin and anti-toxin; a Cagnola prize and gold medal for 1899 on one of the following subjects chosen by the founder, viz: the cure of 'pellagra,' the nature of miasma and contagion, the direction of flying balloons, and the methods of preventing forgery of writings; a Brambilla prize for industrial improvements in Lombardy; Fossati prizes for 1899 on the macro- or micro-scopical anatomy of the nervous system, for 1900 on the regeneration of peripheric nervous fibres in vertebrates, and for 1901 on the anatomy of the encephalus of the higher animals; a Kramer prize for an essay on the transmission of heat between the steam and walls of the cylinders of steam engines; a Secco Comneno prize for 1902 for a description of Italian natural deposits of phosphates; a Pizzamiglio prize for an essay on the influence of socialistic doctrines on private rights; Ciani prizes

for popular Italian books, a Tommasoni prize for a history of the life and works of Leonardi da Vinci; and a triennial Zanetti prize for some improvements or discovery in pharmaceutical chemistry.

UNIVERSITY AND EDUCATIONAL NEWS.

At a meeting of the Board of Overseers of Harvard University on March 15th it was voted to concur with the President and Fellows in the election of William Morris Davis, M.E., now holding the chair of physical geography, to be Sturgis Hooper professor of geology; Robert Tracy Jackson, S.D., was elected assistant professor of paleontology, and Jay Backus Woodworth, S.B., instructor in geology.

DR. SIMON FLEXNER, of the Johns Hopkins University, has accepted the chair of pathology in the University of Pennsylvania, to succeed Dr. John Guiteras. Dr. Guiteras will spend a year abroad and expects then to devote his services to the University of Havana.

MR. H. E. BROWN and Mr. W. A. Niveling, assistant instructors in chemistry in the University of Michigan, have resigned their positions to engage in technical work.

At Yale University Dr. Jervase Greene has been promoted to an instructorship in philosophy and Dr. I. K. Phelps to an instructorship in chemistry. Dr. Milton B. Porter has been appointed instructor in mathematics.

COLONEL HEINRICH HARTL has been appointed professor of geodesy in the University of Vienna, and Dr. G. Bodländer, of Göttingen, professor of physical chemistry in the Institute of Technology at Braunschweig. Dr. Gutzmer, of Halle, has been called to the new assistant professorship of mathematics in the University of Jena; Dr. Aladar Richter to be assistant professor of botany in the University at Klausenburg, and Dr. Bengt Jöhnsson to be professor of botany in the Academy at Lund. Dr. Tobler and Dr. Streckeisen have qualified as docents in mineralogy and geography in the University at Basle. Dr. Ad. Fick, professor of physiology at the University of Würzburg, will retire at the end of the present semester.

SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; J. LE CONTE, Geology; W. M. DAVIS, Physiography; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; HENRY F. OSBORN, General Biology; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; J. McKEEN CATTELL, Psychology; DANIEL G. BRINTON, J. W. POWELL, Anthropology.

FRIDAY, MARCH 31, 1899.

A NATIONAL OBSERVATORY.

CONTENTS:

<i>A National Observatory</i>	465
<i>Discussion of a National Observatory</i> : PROFESSORS SIMON NEWCOMB, ASAPH HALL, C. A. YOUNG, T. C. MENDENHALL, R. S. WOODWARD, C. L. DOOLITTLE, W. H. PICKERING, ARTHUR SEARLE, FRANK W. VERY, DAVID P. TODD, G. W. MYERS, E. A. FUERTES, W. L. ELKIN, JAMES E. KEELEB.....	467
<i>The Atomic Weights—A Quarter Century's Progress</i> : PROFESSOR F. P. VENABLE.....	477
<i>Hermaphroditism in Ostrea Lurida</i> : PROFESSOR F. L. WASHBURN.....	478
<i>Agricultural Electrotechnics</i> : PROFESSOR R. H. THURSTON	480
<i>Scientific Books</i> :— <i>Geology of the Edwards Plateau and Rio Grande Plain</i> : PROFESSOR FREDERIC W. SIMONDS. <i>Solly's Medical Climatology</i> : DR. G. HINSDALE.	481
<i>Scientific Journals and Articles</i>	485
<i>Societies and Academies</i> :— <i>Biological Society of Washington</i> : O. F. COOK. <i>The Washington Botanical Club</i> : DR. CHARLES LOUIS POLLARD. <i>The New York Section of the American Chemical Society</i> : DR. DURAND WOODMAN. <i>Section of Astronomy and Physics of the New York Academy of Sciences</i> : R. GORDON. <i>Academy of Science of St. Louis</i> : PROFESSOR WILLIAM TREELASE.....	486
<i>Discussion and Correspondence</i> :— <i>Plymouth, England, and its Marine Biological Laboratory</i> : DR. EDWARD G. GARDINER. <i>The Duplication of Geologic Formation Names</i> : F. B. WEEKS. <i>The Berlin Tuberculosis Conference</i> : DR. CH. WARDELL STILES.....	488
<i>Astronomical Notes</i> :— <i>The Rutherford Photographs; The Solar Eclipse of May 28, 1900</i> : PROFESSOR WINSLOW UPTON	492
<i>Notes on Physics</i> :— <i>The Effect of Commutators on the Field of Dyna- mos and Motors; Telegraphy and Magnetic In- duction</i> : F. C. C.....	493
<i>The Bequests of the late Professor Marsh</i>	494
<i>Scientific Notes and News</i>	494
<i>University and Educational News</i>	496

MSB. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

THE letters which we publish in this number from prominent American astronomers on the general subject of a national observatory may be regarded as a sequel to Professor Skinner's admirable history of the Naval Observatory found in our issue of January 6th. Justice to the latter institution demands that we should point out certain features of the case which have generally been overlooked. It has been too hastily assumed that the Naval Observatory should fill the requirements of a national astronomical observatory, and that, if it did not, some one must be at fault. To correct this view we have only to cite some authoritative statements on the subject. The matter was stated very forcibly and clearly by Commodore Belknap, Superintendent of the Observatory, as far back as 1885, when the building of the new observatory was about to begin, and when, in consequence, its purposes were the subjects of public discussion. He wrote:

It is first of all a *naval* institution, its astronomical work being, so far as the *naval service proper* is concerned of a purely secondary consideration. * * * * If the time has come when the purely scientific side of the institution has outgrown the needs of the naval service the converse is true, namely, that the navy

has no need of it or of the scientific staff. If the so-called scientific men of the country think that the time has come to apply to Congress for money to build a national observatory the Navy will not stand in their way; only it will take no responsibility for it, and will be glad to see it go to another department of the government, and to be under purely civilian control, including professors with civilian appointments instead of Naval commissions.*

This official view is enforced by the absence of legislation providing for the organization and government of the institution or prescribing its purposes or functions. Not only has Congress never uttered a word as to its purpose, but it has never, so far as we can learn, provided any authority to determine what work it should undertake. The highest officials recognized in the annual appropriations are assistant astronomers, but there is no statement whom they are to assist. Everything else is left with the Navy Department, which has no way to complete the organization except to order naval officers and professors to duty at the observatory, and establish such rules for their guidance as it may see fit. We are not aware that any regulations have ever been issued prescribing a well-defined plan of astronomical observations. All this accentuates the secondary character of its astronomical work, and justifies the modesty of the part which it has played in the progress of astronomy since the new buildings were erected.

If we accept the preceding view of the functions of the observatory, then we are the only one of the great nations that does not support a national observatory for the promotion of astronomical science. The

question is whether our astronomers should not act on the suggestion of Admiral Belknap and petition Congress for the establishment of such an institution as they want. An astrophysical observatory is already supported by Congress under the auspices of the Smithsonian Institution; why should not one for astrometry in its widest range be established under the same or other scientific auspices?

How such a proposal would be met by Congress goes without saying. The first questions would be: Have we not already such an institution? Has not Congress already expended an unprecedented sum in the erection of an observatory? Is it not supported at a greater annual expense than any other similar institution in the world? What has it to do but prosecute the very researches you want prosecuted and make the very observations you want made?

It would be hard to meet these questions without exposing what, at first sight, would seem a weak point. It might not be difficult to convince Congress that an institution where the prosecution of astronomical work was 'of purely secondary consideration,' and which was not specially organized as an institution for astronomical work, could never be expected to fulfil the requirements of a national observatory. But how reconcile the subordination of scientific to naval work with what Congress has actually done? Why should our navy need a great establishment costing nearly a million dollars and fitted up with large and expensive astronomical instruments any more than the English or French or German navy? The English navy has its chronometers rated at the Greenwich Observatory at a very small expense,

*Senate, Ex. Doc., No. 67, 49th Congress, 1st Sess.

and the other countries have small and inexpensive establishments for this purpose. All the national observatories but ours have purely civilian organizations. Why should ours be an exception?

Under these conditions what is wanted is that our astronomers and naval authorities should come together and agree upon a plan. Nothing can be worse than the continuation of a system under which the country goes to all the expense of supporting a great observatory without reaching results commensurable with the expenditure. It is sometimes claimed that naval officers will not give up any part of their control. It seems to us that this claim involves a reflection upon their patriotism and their regard for their country's interests which they should not tolerate. Congress gives its munificent support to the observatory under the belief that it is supporting a great and useful scientific establishment which is extending the fame of our country in the intellectual field as the observatories of Greenwich and Paris have extended the fame of the countries which have supported them. If this belief is ill founded the claim in question amounts to nothing less than saying that our naval officers will fight for the privilege of expending large sums for objects which neither increase the efficiency of the service nor promote the scientific standing of the country in the eyes of the world. We cannot suppose them animated by so low a spirit as this attitude presupposes. We believe that they are sincerely desirous of seeing the great institution established at such expense made a credit to the country, and that if fifty years' experience shows that

this end can be reached only by separating the naval from the scientific work of the establishment, and placing the latter under the only sort of control that can ever be really successful, they will, in the words of Commodore Belknap, 'not stand in the way.' It is the duty of our astronomers to use their influence in making the exact facts of the case known, and in promoting such a solution of the problem as will conduce to the good name of American science.

Were we dealing with a small institution to which Congress extended only a niggardly support, we might look with indifference on a corresponding paucity of performance. But when Congress bestows a far more liberal support on our observatory than England, France or any other nation bestows on its national observatory, and does this in the belief that it is promoting astronomical science to a corresponding extent, patriotism demands that our astronomers should inform our authorities whether this belief is or is not in accord with the fact.

DISCUSSION OF A NATIONAL OBSERVATORY.

IN response to a letter sent to a number of leading American astronomers the replies printed below have been received.*

The letter asked for answers to the following questions:

1. Is it desirable that the government of the United States should support a national astronomical observatory?

* In addition to these replies a committee appointed at the Harvard Conference of Astronomers and Astrophysicists, consisting of Professor E. C. Pickering, Harvard College Observatory (Chairman); Professor George E. Hale, Yerkes Observatory, and Professor George C. Comstock, Washburn Observatory, has drawn up a report on the subject, which we hope to publish after it has been presented to the next Conference.

2. If so, what ends should such an institution have in view; especially to what classes of astronomical observation and research should it be devoted?

3. Does the new Naval Observatory fulfill the objects in question so completely that no other institution of the kind is necessary? If not, in what respects does its work differ from that required for the purposes in view?

TO THE EDITOR OF SCIENCE: In answer to your questions as to the policy of supporting a national observatory, I would say that, making abstraction of features peculiar to astronomical science I see no reason why the government should support an astronomical observatory any more than a chemical laboratory for chemists to use in making their experiments. The exceptional reason in favor of an observatory is that there are branches of astronomical science of world-wide interest and importance which are not adequately cultivated by private enterprise. The greatest of these relate to the motions of the heavenly bodies, especially the fixed stars. Of late years it has been seen that the study of these motions may throw light on problems formerly regarded as insoluble, and supply posterity with records of priceless value in the advance of knowledge.

An institution to supply the want thus indicated should be organized and fitted up with its own special end in view, and should not be diverted from that end by the temptation of more attractive work in other directions. The later results of experience and research should determine the instruments to be used, and the whole arrangements should be such as to command the best talent and skill in planning and executing the work.

SIMON NEWCOMB.

TO THE EDITOR OF SCIENCE: The astronomical questions you propose to discuss in SCIENCE are interesting. Since I hold a position in the Navy it is not proper for me to discuss the conduct of the Naval Observatory. As to the other questions I may say briefly:

1. I think it is desirable that the government of the United States should support an Astronomical Observatory.

2. I think such an observatory should determine the positions of the stars, planets and satel-

lites with the greatest accuracy possible, since theoretical astronomy rests on such observations. The astro-physical departments of astronomy are so attractive that they will not lack investigators.

ASAPH HALL.

HARVARD UNIVERSITY.

TO THE EDITOR OF SCIENCE: Replying to questions raised in your communication of December 4, 1898, I would say:

I. I think that unquestionably the United States ought to support a National Observatory, unless it is willing to fall to the rank of a third-rate nation. Besides, we already have a fine building, with a costly and valuable equipment of apparatus. It would be a disgrace to abandon it.

II. As to the ends to be kept in view, etc., I think a National Observatory, maintained by the government, should aim chiefly at kinds of work not easily within the reach of private and educational observatories—extended series of observations which require persistent prosecution without intermission or material change of plan—such, for instance, as:

(a) Continuous observations of the positions of the sun, moon and planets, partly by the meridian circle, and partly, perhaps, by photography, which is specially valuable in the case of such asteroids, as, for one reason or another, require attention. Observations of comets are also in order.

(b) The determination of the absolute positions of a reasonably large list of fundamental stars, and of such other stars as are needed for reference points by observers of planets or comets, or by those engaged in geodetic operations.

(c) I think it desirable also that certain astro-physical observations should be included, especially in the line of stellar spectroscopy, since the number of objects of investigation in this line is so great that the ground cannot be covered in any reasonable time without the general cooperation of all well-equipped observatories.

(d) The refined reduction and prompt publication of the results of observation. This implies a thorough mathematical study of the theories involved and investigation of their corrections, and requires that among the as-

tronomers of the observatory there be included able mathematicians as well as skillful observers. Joined with this work is very properly the calculation and publication of the National Astronomical Ephemeris, or some definite portion of an International Ephemeris, if such a work can be arranged for, as is now proposed in certain quarters.

III. I do not think that the National Observatory, whether organized as the present Naval Observatory or on any other plan, can wisely undertake to deal with all classes of astronomical observation. There are numerous lines of investigation which can better be followed up by institutions organized for the special purpose, or by individual amateurs. Nor do I believe that under its present organization, nor under any organization which leaves it distinctively a naval institution, managed and directed according to naval traditions and methods, can it ever well fulfill the ends of a National Observatory. The pursuit, and especially the superintendence and direction of astronomical investigation, is purely scientific work, and should be under scientific control.

As to the question whether another observatory (for astro-physical investigation I suppose) should be founded and maintained by the government I am hardly clear. The examples of France and Germany, and to a certain extent that of England, point in this direction. But so long as the observatories at Cambridge, Mt. Hamilton and Lake Geneva maintain their astro-physical activity it seems to me hardly necessary for us to move in the matter.

PRINCETON, N. J.

C. A. YOUNG.

TO THE EDITOR OF SCIENCE: As I am not an astronomer there is no reason why my opinion should appear in your symposium on the National Astronomical Observatory. Your request that I should furnish it originated, doubtless, in the fact that I was appointed, at the Boston meeting of the A. A. A. S., a member of a committee of which Professor E. C. Pickering is Chairman, to consider and report upon the organization and work of the Naval Observatory at Washington, which stands for whatever we have or have not in the way of government astronomical research at the pres-

ent moment. At any rate I will venture upon a very brief discussion of the questions involved as I see them.

To the first question I would reply that we already have and have had for many years a National Astronomical Observatory in the Naval Observatory at Washington. Congress has already shown its willingness to maintain such an institution in the magnificent buildings and expensive equipment for which it has generously appropriated money and for the support of which it makes liberal annual appropriations. It is too late, therefore, to discuss your first query, but the all-important question is the third: Does the Observatory as organized and managed at present fulfill the requirements of such an institution? On this point there is room for much discussion and, perhaps, some difference of opinion. My own answer would be: No. But there is likely to be a tendency to misrepresent the views and attitude of naval officers in this matter, and, without pretending to speak for them or by their knowledge or consent, I venture the opinion that a large majority of them, especially of those generally acknowledged by their comrades to be the foremost men in the service, would be found in substantial agreement with the leading astronomers of the country. It has been my privilege to enjoy rather intimate association with many of them, and I have always found them unselfishly devoted to the best interests of their corps, always ready to discharge in the most conscientious manner any duty with which they may be charged, doing the very best they can under the conditions and restrictions by which they are surrounded.

That they should have a pride in the development of the great institution which has been for so many years under their care is only natural. Originally the Naval Observatory was just what was required by the navy; but, by its gradual expansion into an establishment fitted for astronomical research on an almost unrivalled scale, it has become very much of an elephant on their hands. But to expect that they will voluntarily relinquish all claim to or interest in it is to expect what is unreasonable. I am sure that the great majority of them know that the spirit of a military regime, which is at

once a virtue and a necessity in a military corps, is quite incompatible with the spirit of scientific investigation pure and simple. So long as the Observatory is under a bureau of the Navy Department it must, of necessity, like a navy-yard or a receiving ship, be controlled by naval regulations, and any relations which naval officers may sustain to it must be governed by navy rules regarding rank, short details of service, assignments in regular order without regard to special fitness or taste and other established customs, absolutely necessary to military discipline, but utterly irreconcilable with the spirit of an institution devoted purely to scientific research. The only satisfactory solution of the problem is the removal of the Observatory from military control. No half-way measure, such as appointing a Director from civil life, will avail as long as it remains attached to the Navy Department. The amputation must be clean and complete.

If any attempt is made to accomplish this it must be kept in mind that it is a fundamental principle of bureau administration to get hold of all you can and hold all you get. It is accepted as an evidence of successful administration to have added one or more new functions to the office which you happen to hold, and it is considered almost disgraceful to allow another bureau to begin operations in a field which you have traditionally cultivated, however unrelated they may be to the work for which your corps was originally organized. Much of the useless duplication of government work is due to this.

It must also be remembered that Congress concerns itself very little with what ought to be done, but that it is very greatly influenced by what it is made to believe the people want done. As far as the interests of astronomy go, astronomers are the people. Whenever they are ready to unite in a persistent effort to secure reform in the Naval Observatory, whenever they are willing to exert their influence in favor of making it a real national establishment, directed by astronomers for astronomy they will succeed. Naturally there will be a few naval officers who will seriously oppose any measure which deprives them of such agreeable shore duty, but the great majority of them know very well that to them professional distinction

is to be reached through skill in handling a 10-inch gun rather than a 26-inch objective and that the experience of commanding a battleship is vastly more valuable than anything to be gained in the performance of the petty routine duties of superintending an institution in whose work they have little real interest and no enthusiasm.

T. C. MENDENHALL.

WORCESTER POLYTECHNIC INSTITUTE.

TO THE EDITOR OF SCIENCE: I beg to offer the following replies to the questions you raise with reference to a national astronomical observatory.

First, it is desirable that the government of the United States should maintain an astronomical observatory. The experience of the past two hundred years seems to demonstrate that there are certain kinds of scientific work that cannot be successfully carried on without the express sanction and support of stable governments.

Astronomy, geodesy and geology are the most striking instances of such work, and it is hardly conceivable that they could have attained their existing degree of utility except for the aid extended to them by the leading governments. That the maintenance of such work is second only in importance in national economy to the maintenance of law and order, and to the diffusion of education, is a proposition which few readers of SCIENCE are likely to controvert.

Secondly, the chief objects of a national astronomical observatory seem to fall under the following heads: (a) the registration of continuous series of observations of the sun, moon, planets and fixed stars; (b) the preparation of ephemerides of these celestial bodies for the use of surveyors, geodesists and navigators; (c) theoretical investigations with reference to the motions and physical properties of the celestial bodies, and with reference to the instruments, appliances and methods used in astronomical observations and computations; (d) the cooperation with other similar organizations in astronomical undertakings of international importance.

Thirdly, it may be said that the existing Naval Observatory has fulfilled and still fulfills

these objects. It must be admitted, in fact, that the Naval Observatory, during the half century of its existence, has done a large amount of first class work, and that its service has been dignified by the connection with it of some of the most eminent American astronomers. Nevertheless, it appears equally just to affirm that the administration of the Naval Observatory has never been favorable to the highest efficiency of such an organization. The scientific work of the Naval Observatory has been done in spite of a bad form of administration rather than by reason of a good one.

The radical defect of this administration lies in the assumption that the Superintendent of the Observatory should be, as he has been, generally, a naval officer, who may have little knowledge of or interest in astronomy. The position is one of pleasing prominence to an officer on shore duty, and is hence likely to fall to one who has 'pull' with the party in power rather than to one who has distinguished himself as an astronomer. The effect of such administration is much the same as would result in a university if the department of mathematics, for example, were placed in charge of a superannuated clergyman. The routine work goes on pleasantly, but with no scientific energy except that which the subordinates get from external professional associations. Subordinates who are exceptionally able may, as some have done, accomplish much good work under such depressing circumstances; but those less ambitious are apt to lapse into mere time servers. This form of administration leads also to pressure for position in the service by those little competent to undertake astronomical work. The way in which some of the highest positions on the Naval Observatory staff have been obtained in recent years, through 'pulls' and 'influence,' and competition of all kinds except that of merit, is a standing disgrace to all men of science.

To remedy these defects, and to make of the Naval Observatory a National Observatory, some rather radical changes are essential. The Observatory should cease to be a mere bureau or appendage to the navy, and the surest way to accomplish this end will be to transfer the Observatory to some other department. The

Director or Superintendent of the Observatory should be an astronomer of acknowledged ability, and the members of his staff should be chosen by reason of merit only. The conduct of the work of the Observatory should be subject to the approval of a board of regents, similar to that of the Smithsonian Institution, half of whom should be chosen from astronomers and physicists not in the government service, and half from members of Congress. Some such system of administration, free so far as practicable from the contamination of spoils and politics, appears to be absolutely indispensable to the maintenance of an Observatory worthy of American science.

R. S. WOODWARD.

COLUMBIA UNIVERSITY.

TO THE EDITOR OF SCIENCE: In reply to your questions relating to the United States Naval Observatory I assume that you do not expect an elaborate article, but merely the expression of my individual opinion in a few words. I take the topics in order.

I. If no such establishment existed, and it were a question of founding an observatory, I should say *no*. At least not before government methods had considerably improved.

With buildings and plant on hand, which have cost nearly a million of dollars, it is probably best to keep it up, though I am not quite sure of this.

II. Systematic work with meridian circle in determination of places of stars and planets. Measurements of double stars and positions of comets and minor planets with the equatorial. In short, the kind of work which Hall and Eastman kept up for many years and which is not likely to receive the necessary attention at private observatories.

III. I do not quite understand this question. If the meaning is as follows: Is it desirable for government to establish another observatory in order to atone for the shortcomings of that now existing? there can be only one answer.

The requisite conditions, in my opinion, are not likely to be fulfilled by any observatory established within the political atmosphere of Washington.

C. L. DOOLITTLE.

FLOWER OBSERVATORY.

TO THE EDITOR OF SCIENCE: In reply to question number one I should say: Had we no observatory, no. It does not require a 26-inch telescope to test a chronometer. (2) Since we already have such an institution, it seems to me that the best work it can undertake will be large and expensive pieces of routine work, such as a private observatory would be unlikely to take up, and could only be accomplished by a combination of them. (3) The Naval Observatory certainly does not fulfill this idea. The work it is to undertake should, I think, be decided by a committee suitably appointed. It should have a civilian astronomer at its head.

W. H. PICKERING.

HARVARD COLLEGE OBSERVATORY.

TO THE EDITOR OF SCIENCE: The question whether the United States should maintain a National Astronomical Observatory must largely depend for its answer upon the opinion which we may adopt with regard to the propriety of employing money raised by taxation in the support of any branch of pure science. It may be held that the taxpayers should not be made to contribute to undertakings in which they cannot be supposed, as a whole, to feel any decided interest, and which, so far as they are beneficial, must benefit mankind at large, rather than the particular nation supporting them. But various branches of applied science must be cultivated at the national expense, and it is difficult to draw a definite boundary separating abstract inquiries and their practical applications. Some liberty of research, too, on the part of men engaged in any scientific work, seems desirable to prevent them from falling into too mechanical a routine. In this country, where the science of astronomy is so liberally supported by private munificence, there is, doubtless, very little occasion for a National Observatory; still, since such an institution exists, and has done much interesting work, as Professor Skinner shows, most of us would probably dislike to have it abandoned without further trial.

The most obviously valuable service which a National Observatory can render is the maintenance of such observations as are apt to be neglected elsewhere, from their want of im-

mediate interest. Such, for example, are the determinations of position of the sun, moon and planets, which have been kept up assiduously at the Naval Observatory since 1861, as Professor Skinner assures us at the close of his article. It would hardly be advisable to confine the work of the institution rigidly to a routine of this kind, so planned as to leave the astronomers no time for pursuits more stimulating to the intellect; but if they should attempt to undertake all kinds of researches most in vogue at the present moment we could not expect from them many solid additions to human knowledge.

I do not feel myself competent to judge whether the Naval Observatory is to be regarded, comparatively speaking, as a success or as a failure, or whether any change in its organization would decidedly improve it. I know that complaints of the amount and quality of its work have often been made, and I have been puzzled by the manner in which these complaints have been met. In similar cases we usually find the persons criticised inclined to excuse what may seem to be their shortcomings by their want of means, or by the uncertainty whether their present pecuniary support will be continued, or, perhaps, in other instances, by a defective organization imposed upon them from without. But, unless I misunderstand what I have heard, the astronomers of the Naval Observatory generally agree that their chief has all necessary power to carry out his plans promptly and effectively; that this power hardly needs to be exerted, because they form a united and harmonious body, animated by purely scientific zeal; that Congress has supplied them abundantly with funds, and that they entertain no apprehension that this liberal support will be withdrawn, or that they will be under the necessity of neglecting their scientific pursuits in order to solicit its continuance. If this impression of mine, which I acknowledge to be a vague one, is correct, either the critics must be in error or there is something in the mere atmosphere of Washington, or in any connection with the government of the United States, which is unfavorable to the cultivation of astronomy.

Public criticism of a public institution must

not be blamed, even if it is ill founded; and I am inclined to depend upon it for the correction of any defects which may exist in the management of the Naval Observatory. If the critics cannot agree among themselves no change is probably required, but if there is a general accord among them it will be difficult for the Washington astronomers to persist in opposition to the scientific sentiment of the country. For example, the publication of the Washington observations has often been considered needlessly irregular and dilatory. If this criticism is just, and if the Naval Observatory has ample means for the reduction and publication of its work, I can hardly doubt that the mere repetition of the complaint will before long succeed in removing the occasion for it.

ARTHUR SEARLE.

HARVARD COLLEGE OBSERVATORY.

TO THE EDITOR OF SCIENCE: Your questions are fundamental.

1. The right to existence of a National Astronomical Observatory supported by the United States seems to me beyond dispute, and this too for the reason that certain classes of astronomical observations, such as those of the positions of sun, moon and the larger planets, must be maintained with a regularity seldom attained in an observatory subject to the vicissitudes of a changing policy or to the fluctuation of available funds. In general, those researches which demand long series of observations whose accumulation is likely to outlast the activity of an individual astronomer require an institution having the stability of a National Observatory.

For example, Holden's inquiry as to the evidences of change of form in nebulae, which appeared in the Washington Observations for 1878, is a preliminary discussion whose final answer can best be given by comparison of a series of photographs taken under identical conditions at regular intervals and accumulated perhaps for some centuries. Such a work seems eminently suitable for a National Observatory.

But (3) the New Naval Observatory does not now fulfill, and need never fulfill, these objects so completely that the cooperation of other institutions shall be unnecessary; and a

carefully considered scheme for the division of labor and the cooperation of working astronomers would add to the efficiency of every observatory in the land. Indeed, it may be said that already, without any set compact, there is a tacit recognition of the fitness of individuals for special work, and a partial relinquishment of such work to the men whose attainments, or the institutions whose outfits, promise the best results.

It would be very easy to criticise the present Naval Observatory, but probably few of us could do better under the existing system, which is not sufficiently elastic, and which fails to recognize that Science is like a living plant and must have room to grow. I will confine myself to one example. The accumulation of accurate magnetic records, and their comparison with cosmic phenomena, ought to be an uninterrupted work, undertaken with the design of making it permanent, and as such it is suitable for a National Observatory. The folly of continuing magnetic observations in the rapidly altering environment of a great city, where electric currents generate a variable magnetic field of their own, has been abundantly demonstrated. Scientific opinion and common sense demand the immediate removal of the magnetic part of the working outfit of the Naval Observatory to one or more suitable localities, far removed from civilization, but the sluggish response of a conservative authority which finds it difficult to conceive of a National Observatory in any other place than Washington, D. C., bids fair to leave a gap in our records unless individual action comes to the rescue. Now, while it is not desirable that an institution having the especial character of permanence should shift its policy on small provocation, there ought be freedom to meet emergencies.

FRANK W. VERY.

BROWN UNIVERSITY.

TO THE EDITOR OF SCIENCE: In response to your significant enquiries:

1. *Is it desirable that the government of the United States should support a national astronomical observatory?*

Yes, the United States, as a leading nation of the globe, is virtually pledged to equip and

maintain an astronomical observatory of the first order.

2. *If so, what ends should such an institution have in view, especially to what classes of astronomical observation and research should it be devoted?*

Such classes of observation and research should be conducted as will be of the utmost practical utility :

(A) Observations for determining the precise positions of the stars upon the celestial sphere.

(B) Spectroscopic observations of precision for determining the motions of fixed stars toward and from the solar system.

One telescope of exceptional size should be devoted to this work.

(C) Determination of the distances of the principal fixed stars.

(D) Accurate evaluation of the elements concerned in the motion of the earth's pole of rotation.

A zenith telescope of the best construction, preferably photographic, should be constantly employed upon this research. Cooperation with the Coast and Geodetic Survey, and the uninterrupted support of an additional observer in Manila or Honolulu, is highly desirable. This service should be maintained with the utmost rigor for at least twenty-five years.

(E) Meridian observations of position of the sun, moon and major planets.

Planetary observations should be converted into errors of celestial longitude and ecliptic north polar distance, and equations formed connecting these errors with the elements of the planetary tables used in the preparation of the Nautical Almanac.

(F) Searching investigation of the constant of meridian refraction should be conducted uninterruptedly throughout a series of years.

(G) Equatorial observations not previously specified. These need be but few.

(H) Solar research in several departments.

1. The spots, their number and area, photographically and visually. An independent record should be maintained in either Manila or Honolulu, thereby supplementing, at half intervals, the similar work at Greenwich, Dehra Dûn and the Mauritius.

2. The prominences, photographically and visually.

3. The faculæ, with the spectroheliograph.

4. The corona, during total eclipses, chiefly photographically.

5. The Sun's Reversing Layer.

6. Bolometric investigation of the infra-red rays of the solar spectrum.

7. The permanency in character or the secular variation of lines in the solar spectrum.

8. The permanency or secular variation of the solar constant. In the prosecution of 6, 7 and 8 a high-level station might advantageously be maintained, in either Hawaii or southern California.

(I) The department of the Astronomical Ephemeris and Nautical Almanac should not only prepare and publish this work, at least three years in advance, but should issue also accessory publications of especial service to navigators.

(J) Magnetic observations ought to be maintained, as regards declination, dip and intensity.

(K) A time-service must be maintained, not only for the purpose of the Navy, but for the wide distribution of standard time and the dropping of time-balls at important localities.

The Superintendent or Director of the government observatory should be held responsible for the efficient prosecution of all branches of the work under his charge and for its prompt publication. Also he should be empowered to choose his subordinates, with or without examination, their recommendation for appointment to be subject to approval by a Board of Visitors at semi-annual sessions. Advancement and discharge should be regulated in a similar manner.

DAVID P. TODD.

OBSERVATORY HOUSE, AMHERST, MASS.

TO THE EDITOR OF SCIENCE: To the three questions submitted to me a few days since by yourself I would reply as follows:

1. It is most emphatically desirable that the government of the United States should support a National Astronomical Observatory. There are certain important lines of astronomical research which are of a character such as not to appeal to the popular interest and which, if left to be taken care of by private endowment,

will not receive proper attention. To these the institution should be devoted.

2. Such an institution should have in view research work primarily. The training of specialists should not be ignored. The lines of astronomical research which should receive special, if not exclusive, attention by such an institution should lie within the scope of what is recognized by astronomers as astronomy of precision, though I would not exclude from the realm of precise astronomy some lines of astro-physical research.

3. Most emphatically it does not. Routine work, such as the rating and testing of chronometers and operating a time system, etc., should be no part of the work of a National Astronomical Observatory. The organization of the observatory should not be such as to hinder the most efficient service of its officers nor to curb or discourage the ingenuity of subordinates. Individual initiative should be given freest play. The machine system of Sir George B. Airy, more in vogue elsewhere than in the New Naval Observatory however, and so enthusiastically befriended by directors of observatories, should have no place in its organization, or operation. It should not be a *one-man* institution in the sense that most institutions of this sort have been which have been called into existence among us in these latter days and have too frequently been made to play the part of machines to lift their directors into notoriety. In a single word, the organization of the institution should be democratic and not autocratic.

G. W. MYERS.

UNIVERSITY OF ILLINOIS.

TO THE EDITOR OF SCIENCE: I will briefly answer your questions even though I do not feel suitably prepared to offer unanswerable proofs or cite dates, events, etc.

1. I feel that it is imperative that the government of the United States should support a National Astronomical Observatory, not necessarily at Washington.

2. Only through the work of that Observatory the usual tables of coordinates and other data can be efficiently and officially produced to serve the purposes of navigation, etc.

3. The Naval Observatory does not fulfill all

the conditions that it should, so as to bring to American science an amount of credit proportional to what is done in other branches of the government. The National Observatory should make investigations of all kinds with reference to astronomy, geodesy, meteorology and also in astro-physics. It should largely extend its list of apparent places and also add to the American Ephemeris a larger list of mean places for the better determination of latitudes throughout the country.

4. I can see no reason why the National Observatory should not engage in every branch of astronomy in which other observatories are at work. The only trouble lies in the administration of the National Observatory. I do not know how things are there at present; but our Observatory used to be a source of pride and usefulness to American scientists; and since it has been placed under the control of line officers it has done very little remarkable work, and several of its best men have gone elsewhere. It seems that military life leads even the best of men to do routine perfunctory work, and when the line officers look down upon the Naval Observatory professors as subordinates or inferior beings there are a large number of considerations which tend to diminish the ambition which is the result of industrious zest in scientific work.

I cannot see why the United States government could not have in this astronomical observatory great men adequately paid, in a perfectly defined high social position, and with sufficient appropriations to be engaged in useful research. The nature of the case demands the existence of several observatories, properly located geographically within our vast domain, which now extends around the earth.

E. A. FUERTES.

CORNELL UNIVERSITY.

TO THE EDITOR OF SCIENCE: In answer to the questions you have laid before me I may say:

1. In my opinion there can be but little doubt as to the desirability of a National Astronomical Observatory, supported by the government of the United States. Our geographical position on a meridian one quarter way or more around the globe from those of the great Euro-

pean national observatories affords the means of supplementing, in a valuable manner, the work carried on by them; while our more southern latitude extends the limit and increases the accuracy of useful observation below the equator.

2. The sphere of work of a National Observatory appears to me to comprise mainly such classes of research as cannot well be undertaken by university observatories. Of these we have quite a number, some with the most powerful of equipments, but in general they are likely, I think, to devote themselves to investigations which promise an immediate return of results. The systematic continuous observation of the bodies of the solar system for position, such as has been prosecuted at Greenwich; the construction of catalogues of fundamental stars, such as those furnished by the Pulkowa observatory; the procuring and measurement of photographic plates of the heavens on the plan inaugurated by the observatory at Paris, seem to me, for instance, fields which require such large resources as scarcely any but a national institution can command.

3. I should consider the present site of the New Naval Observatory an admirable one and the equipment in a considerable degree sufficient for the purposes of a National Observatory. There should, doubtless, be added a powerful photographic apparatus.

W. L. ELKIN.

YALE UNIVERSITY OBSERVATORY.

TO THE EDITOR OF SCIENCE: At your request I give my opinion on some questions relating to the establishment of a national observatory in this country, although I believe that it does not differ materially from the opinions of other American astronomers.

It seems to me highly desirable that the United States, like other leading governments, should support a national astronomical observatory. In the U. S. Naval Observatory, the honorable history of which has recently been so well told in these pages by Professor Skinner, the government already possesses suitable buildings and instruments and certain changes in the organization are alone required to convert this institution into a national observatory of the first rank.

The opinion, which is probably widely held among astronomers, that this observatory would be benefited by a change in its organization, is based on general considerations and does not reflect on any individuals or class of men. The splendid efficiency of our naval officers in their own profession is due not merely to natural ability and aptitude, but to a long course of preparatory technical training. Astronomy is likewise a science which demands the whole of a man's best energies. Common sense, therefore, as well as the example of other nations, clearly indicates that a national observatory should be under the charge of an officer who has made astronomy his life work. To place it under the charge of one whose training has been along different lines is as objectionable as would be the appointment of civilians to responsible military commands.

The work of a national observatory would naturally lie mainly in the field of the older astronomy, more particularly in the making and discussion of those fundamental observations of the positions of the heavenly bodies which owe a large part of their value to their continuity, and which, therefore, require permanent, thorough organization and secure financial support. The private or small observatory enjoys the privilege, in some degree compensatory for the many disadvantages under which it generally labors, of taking up researches of doubtful promise without being called to account in case of failure. The elaborately equipped and organized government institution devotes most of its energies to work of which the results are certain, the exploration of new fields and experiments in general having only a secondary place in its program.

Professor Skinner's article shows that only a small part of the work done at the Naval Observatory has any direct reference to the needs of the Navy Department, while by far the greater part is such as would properly come under the province of a national observatory. The requirements of the navy could, I think, easily be met by a national observatory by adopting such methods of coöperation as already exist in other parts of the government service.

JAMES E. KEELER.

LICK OBSERVATORY.

THE ATOMIC WEIGHTS—A QUARTER CENTURY'S PROGRESS.

It may be of interest so near the close of the century to follow a good commercial precedent and make an inventory and strike a balance so as to gain some idea of the progress in chemistry. One portion of our stock in trade has caused us a great deal of trouble all through this century. It was in-

by Mendeléeff in the construction of his first table and that given by Fownes, whose text-book was very largely used in England and in this country. For the later comparison we will make use of the tables given by the American and German committees. Sixty-three elements come under the comparison in the former case and seventy in the latter. The comparative table follows:

COMPARISON OF LISTS OF ATOMIC WEIGHTS.

										Mendeléeff and Fownes.	American and German.
No. atomic weights differing by less than	0.1									35	46
" " " " " " " " " " " "	0.1 and less than	0.2								4	9
" " " " " " " " " " " "	0.2 " more than	0.5								6	11
" " " " " " " " " " " "	0.5 " " " " " " " " " "	1								4	4
" " " " " " " " " " " "	1 " " " " " " " " " "	2								4	..
" " " " " " " " " " " "	2 " " " " " " " " " "	5								5	..
" " " " " " " " " " " "	5 " " " " " " " " " "	10								2	..
" " " " " " " " " " " "	10 " " " " " " " " " "	..								3	..

troduced as a 'new line' at the beginning of the century and has been of the greatest value, but has suffered from serious fluctuations. The so-called chemical constants, namely, the atomic weights, which should be constants but have not been, have for the larger part of the century been in a humiliating condition of incertitude. But they are improving, settling down to their true values, as it were, and there is cause to take heart of hope concerning them.

Some thirty years ago the Periodic System was announced. The atomic weights had emerged from the slough into which they had sunk by the middle of the century, thanks to the labors of Cannizzaro, Williamson and others, but still there was very little unanimity except with regard to those for which the fewest data were in our possession. It is difficult to select for comparison any representative tables of atomic weights for these earlier years, as none were authoritative. In those days there were no national nor international committees to consider these matters. We shall not go far wrong, however, if we take the list used

While much is left to be desired, the improvement is most gratifying. In the earlier tables 55.5 per cent agreed within 0.1 of the value. The majority of these as given in the table were whole numbers and were simply rounded off because the fractions were unknown. The tables of 1899 give 65.7 per cent. of all the elements as agreeing to the same extent, and here the most scrupulous care has been observed in recording the fractional portions. Nearly eighty per cent. of the atomic weights used at present vary by 0.2 or less where in the earlier tables this proportion was only sixty-two per cent. Nearly thirty per cent. of the earlier atomic weights varied by 0.5 or more where only five per cent vary now. None of the present atomic weights vary by more than one whole number where fourteen varied a quarter of a century ago, five of these varying by more than five integers. It is evident that the list is narrowing down and that this blot of ignorance and inaccuracy which has rested upon the science will soon be removed. Few realize how great the army of workers along this line

has been and how much work has been accomplished. About one hundred and fifty new determinations of atomic weights have been made in the last twenty years. Still a great deal more work remains to be done.

F. P. VENABLE.

UNIVERSITY OF NORTH CAROLINA.

HERMAPHRODITISM IN *OSTREA LURIDA*.

WHILE doing some work for the United States Fish Commission, during the summers of 1897 and 1898, to determine the possibility of propagating Eastern oysters on the Oregon coast, I had an excellent opportunity to study the question of the sex of this West coast oyster. To the best of my knowledge, this question has never been approached hitherto.

During the spawning season of 1897 individuals emitting sexual products which

identity of these sexual products obtained from the visceral mass; even with the naked eye the granular appearance of the eggs is distinct and pronounced, and the thick, creamy consistency of the non-granular male fluid can never be confounded with them.

In my notes for 1897 there is no mention of finding ova mingled with spermatozoa in the examination of living products with the microscope. But, after staining and sectioning a number of individuals, *all of which are labelled males*, I almost invariably found ova in the generative follicles, and amongst them I observed small, deeply-stained bodies in dense masses, which I was led to conclude, even on a preliminary examination, were masses of spermatozoa (see Fig. 1, *Camera lucida* drawing B. & L., O. 1. Obj. $\frac{1}{2}$). This belief was strengthened on using a $\frac{1}{2}$ hom. imm., by which I could see occasional faint projections from the small bodies referred to, which projections I assumed to be the tails of the spermatozoa, the dots representing the nucleated heads. The finding of ova in these sections was, of itself, startling, for when alive and tested for sex they gave unmistakable evidence of being males. In the figure, which only represents a portion of one generative follicle, four of the ova show germinal vesicles.

This season I gave more particular attention to the microscopic examination of living specimens. The seemingly conclusive results from the study of many individuals is here given. In a specimen of fluid from a male I observed, among free spermatozoa covering the field, collections of sperm cells which I will call 'sperm masses.' Each sperm cell in a mass possessed a tail, and these tails, actively waving to and fro in the salt water under the cover slip, caused the mass to move about. These tails were seen fairly well with a $\frac{1}{2}$ obj. These living sperm masses I regard as identical with the deeply-stained masses seen among the ova



FIG. 1.

proved under a magnifier to be in some cases sperm and in other cases eggs were carefully labelled and separately preserved in different media. As in *Ostrea Virginica*, there is no possibility of mistaking the

in sections, an example of which is shown in Figure 1. Figure 2 shows free sperm and sperm masses as they appeared in the

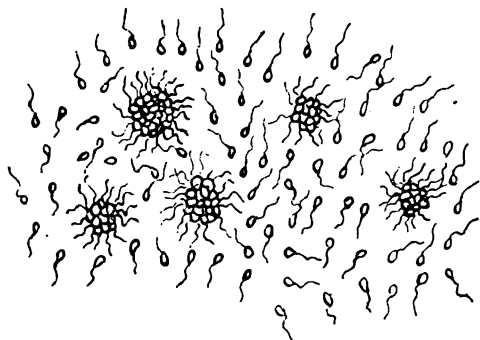


FIG. 2.

field of the microscope. Several oysters, evidently males, were opened with the same results. It yet remained to find living ova in specimens containing spermatozoa in order to more fully support my conclusions as regards the bisexual conditions of this species. This was not difficult, for I shortly discovered in a specimen several immature eggs floating amongst spermatozoa and sperm masses. None of these ova were be-

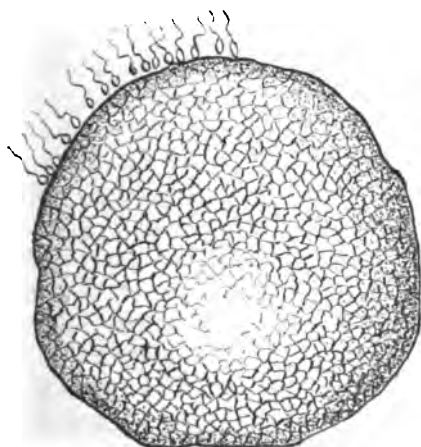


FIG. 3.

ing attacked by the male cells. Later, in a specimen full of spermatozoa, I found a mature egg, completely surrounded by male cells, which were attacking it with great vehemence. Figure 3 (cam. luc. O. 1, Obj.

$\frac{1}{8}$) shows this egg, the light area evidently denoting the position of the germinal vesicle.

In the drawing only a portion of the periphery is represented as being attacked. We know that in *Ostrea Virginica* the egg does not become round until fertilized. Arguing from analogy the egg shown above has been fertilized.

From the results of the work described above I have no hesitation in declaring that *Ostrea lurida*, the native oyster of the Northwest coast, is hermaphroditic.

In this connection it is interesting to note that Karl Möbius, in 1871, claimed that the sexes of the European oyster, *O. edulis*, are separate at the breeding season (*vide* his 'Untersuchungen über die Fortpflanzungsverhältnisse der Schleswigschen Austern.' In 1877 ('Die Austern und die Austernwirtschaft') he concluded that the sex of the European oyster changes after the reproductive elements have been discharged from the body. He has hardly valid reasons for this conclusion. Professor John McCrady ('Observations on the Food and Reproductive Organs of *Ostrea Virginiana*, with some account of *Bucephalus cuculus*;' Proc. Boston Soc. of Nat. Hist., Dec. 3, 1873) declares that he saw in *O. Virginica*, among small immature ovarian eggs, spermatozoa, separate and in masses, moving about without attacking the eggs and without any apparent change taking place in the young germinal vesicle. *

F. L. WASHBURN.

BIOLOGICAL LABORATORY,
UNIVERSITY OF OREGON, November 16, 1898.

* In connection with Professor Washburn's paper it may be desirable to quote the following note, from the Proceedings of the Academy of Natural Sciences of Philadelphia (1892, p. 351), to which Professor Conklin has called our attention. "The Hermaphroditism and viviparity of the Oysters of the Northwest Coast of the United States. Professor J. A. Ryder reported on behalf of Professor R. C. Schiedt of Franklin and Marshall College, Lancaster, Pa., the latter's discov-

AGRICULTURAL ELECTROTECHNICS.

M. PAUL RENAUD has recently contributed an extensive and valuable paper on applications, effected in Germany, of electrical engineering in the processes of agriculture, and remarks upon its future in France and her colonies.*

An earlier paper had been contributed by the same writer on the subject of agricultural electrical engineering, in which he had endeavored to exhibit the possibilities of such applications, and the present publication has permitted the review of progress to date in realizing earlier dreams and hopes. He proposes, later, to study the progress of this new art and applied science in the United States. In Germany the government has placed its own domains at the disposition of investigators and experimentalists, and the German Society of Agriculture has established exhibitions and competitions resulting in the general dissemination of knowledge thus acquired among its members and agriculturists generally.

In the production of this form of energy the wind has been availed of; the system of M. La Cour permitting the use of windmills by insuring a satisfactory system of regulation of mill and dynamo. Water-

ery of the fact that the oysters native to the north-west coast of the United States are hermaphrodite and viviparous. Specimens from the coast of Oregon and Washington show that the same conditions exist in the reproductive follicles as in those of *Ostrea edulis* of Europe. The presence of eggs and of spermatozoa in the same follicle is the invariable rule. The ova, like those of *O. edulis*, are much larger than those of *O. virginica*, though perhaps not quite so large as the former. The embryos are fertilized in the gill and mantle cavities, where they undergo development."—Ed. SCIENCE.

* L'Électrotechnique agricole en Allemagne, son avenir en France and dans nos colonies; par M. Paul Renaud, ingénieur, ancien élève de l'École de Physique et Chimie industrielles de Paris; Bulletin de la Société d'Encouragement pour l'Industrie Nationale; Paris, Jan., 1899; p. 15.

power has become the principal source of power in this work in many sections of the country, and its regulation has also been made effective, in some cases, by Reiter's electric brake and governor, as constructed by the Reiter Co., at Winterthur (Switzerland). Like all hydraulic regulators, however, it is costly, its price being about \$400.

Recently the gas and petroleum motors are coming into use as prime motors for agricultural work of this character. They are considered to exhibit great advantages over the preceding forms. The use of producer gas ('gaz pauvre') is said to give the horse-power at about one-half the cost, in fuel, of the power of the steam-engine, and it requires far less careful or continuous supervision than the latter. Körting, of Körtingsdorf, has taken the lead in the introduction of this system. A double-cylinder gas-engine and direct-coupled generators are usually found most satisfactory. Costs decrease with increase in the proportion of time of operation, and the mean given corresponds to pretty nearly a variation as the fourth root of the annual time of working in hours.

The costs of transmission of the electric energy and of its application in ploughing, in the transportation of merchandise and in other farm operations, are stated as resulting from experience of the character indicated, and it is finally concluded:

1. The electric installation may be employed where a prime motor is already in place, as a steam-engine or a water-wheel, for the purpose of transmitting that energy to the point at which it is proposed, for a time, to perform work, as of operating the plough, centrifugal pumps, etc., in the field, and the various apparatus of the farm, within and without the buildings.

2. The electric plant may be installed at any point found convenient or desirable, as it can be arranged to supply the required power at any point, near or far, over a small

copper wire at little cost in time, trouble or money.

3. The same motor may be employed for various purposes, successively and at any time, with any forms of agricultural machinery; its small size and portability permitting its transport from one point to another with ease.

4. The facility with which the current may be divided and applied permits its use in driving a number of machines, of various forms, at the same time and in different places.

5. It allows the supply, at the same time, of power for machinery and for light and even for heat.

6. It affords safety against fire, where properly established, and heat, light and power may be thus furnished at minimum risk.

7. The manipulation of the apparatus is simple and easy.

8. This system permits the instantaneous operation of fire-pumps to confine and arrest an incipient fire; it being provided with a suitable system of distributing water mains.

9. By use in prompt suppression of epidemics, by destroying the first cases, extensive contagion and resultant dangers and sacrifices of life and property are avoided.

It is thought that the great sub-division of agricultural lands in France will prevent the introduction of such systems as rapidly as is desirable for the purpose of successfully competing with adjacent countries of Europe. But it remains for the electricians and engineers to secure capital, to distribute electrical energy at low costs, to rent out apparatus and even to see it properly manipulated by furnishing expert operatives, in order that the peasant may not be called upon to provide capital which it is almost impossible for him to find. The agriculturists must combine, form syndicates, and thus make powerful that energy

which is powerless in single and separated elements. The great proprietor will find it to his advantage to lead in the introduction of the new systems; setting an example to his neighbors that may later prove fruitful of great good.

In the colonies, it is stated, a spirit of threatening democracy is likely to make them, for a long time, comparatively unproductive, and even the legislators are not always without blame. "They go to their constituents with a cry against machinery which has always been most vehemently raised among these classes, especially against the introduction of machinery for hand-work." The fact is, of course, precisely the opposite, and the introduction of machinery has always benefited the workmen more than other classes. "Augmenting the returns to the proprietor, they permit him to raise the wages of those who continue to work on the soil."

R. H. THURSTON.

SCIENTIFIC BOOKS.

Geology of the Edwards Plateau and Rio Grande Plain adjacent to Austin and San Antonio, Texas, with Reference to the Occurrence of Underground Waters. By ROBERT T. HILL and T. WAYLAND VAUGHAN. From the Eighteenth Annual Report of the United States Geological Survey, 1896-97, Part II.—Papers Chiefly of a Theoretic Nature, pp. 193-321; pl. xxi.-lxiv. Washington, Government Printing Office. 1898.

This is, without doubt, one of the most important contributions to Texas geology in recent years. While the purpose of the authors is primarily to deal with the artesian water problem, they have in reality done much more, as is at once apparent by reference to their complete and detailed descriptions of the geology of this region.

"The artesian wells of the eastern half of Texas belong to several distinct systems, the term 'system' including all wells having their source in the same set of rock sheets or strata. * * * In the Cretaceous formations

alone there are no fewer than five, and two of these—the Travis Peak, or Waco, and the Edwards—receive consideration in this paper.”

To those familiar with the Texas Cretaceous a change in nomenclature is at once noticeable—the term ‘Travis Peak’ being employed for the formation heretofore known as ‘Trinity Sands,’ and ‘Edwards’ for the ‘Caprina limestone.’ These and similar changes are made, as the authors state, by refining the previous nomenclature, appropriate geographic names being substituted wherever possible for paleontologic and mineralogic terms.

An investigation of the source of the artesian water at and in the vicinity of San Antonio was productive of the following results: “That while these well waters come from the same series of beds that supply the artesian wells of the Waco, Fort Worth and Dallas region north of the Colorado, their occurrence presents some important differences of detail. Instead of having their immediate source in beds of porous sands, like the wells about Waco, they are derived largely from the Edwards limestone, hitherto supposed to be one of the most impervious formations of the whole Cretaceous section” (p. 200). “It became apparent,” the report continues, “that this hitherto unappreciated water-bearing formation had great possibilities for supplying with flowing or non-flowing wells a large area of country lying between Austin and San Antonio, extending west of the San Antonio River along the northern margin of the Rio Grande Plain towards the Pecos River, and even comprising the extensive summit region of the Edwards Plateau” (p. 200).

Two classes of outflowing waters are recognized—the one following the margin of the Rio Grande Plain, the other appearing in the canyons of the Edwards Plateau.

The introduction which has here been briefly outlined gives but a faint idea of the detailed work which has been so creditably done by the authors.

The geography of the region is now taken up, the chief features of which are the Rio Grande Plain, the Edwards Plateau and its ‘jagged southeastward front’ called the Balcones Scarp. “Broadly considered, they are a lowland plain inclining gently southeastward to the Gulf of

Mexico, an upland plain rising gradually towards the northwest, and a rugged zone of separation which includes a quick ascent from plain to plain.”

The Rio Grande Plain is characterized by a low relief, yet attention is called to the fact that occasionally hills of considerable magnitude are encountered; buttes, capped with limestone, or sedimentary below and igneous above; old volcanic necks, as Pilot Knob, south of Austin; rounded masses of basalt, as Sulphur Peak, in Uvalde county. “The Anacacho Hills, extending east and west in southern Kinney county and constituting the most rugose part of the plain are of still another type, consisting of a monoclinical plateau, or cuesta, sloping southward and presenting a steep scarp to the north.”

Climatically the plain may be divided into the eastern, or humid and sub-humid region and the western, or arid region. Beyond Bexar county continuous cultivation is impossible on account of aridity.

The Balcones Scarp, the position of which “is determined by a complex dislocation of the rocks, the Balcones fault,” is the dissected edge of the Edwards Plateau. Numerous hills of denudation, locally known as mountains, here rise above the Rio Grande Plain—in the vicinity of Austin, 400 feet; in Uvalde county, 1000 feet.

The elevated Edwards Plateau merges into the Llano Estacado. Between them there is no definite line of separation, yet their surface characters, soil and rocks, give to each a peculiarity of its own.

The main drainage of the Edwards Plateau is to the east and southeast, and, as its watershed lies well to the westward, the erosion of the streams flowing into the Pecos is but moderate.

The observer in crossing the Balcones line “experiences a sudden and complete change of scenery, with accompanying changes in floral, geologic and cultured conditions.” Three simple topographic elements are presented, viz.: “The flat-topped summits of the decaying plateau; the breaks or slopes of its crenulated borders and canyoned valleys; [and] the stream ways.”

The cap-rock of the plateau is the Edwards (Caprina) limestone.

As the streams of this region have an important bearing upon the underground flow of water, the Rio Frio has been selected as a type and described in detail. "The caletas and upper canyons are usually dry and waterless arroyos, except in time of storm. The flat-bottomed canyons contain permanent pools of flowing water, fed by springs and on the lower plain the running water disappears entirely or for a considerable distance."

Brief mention is also made of the caverns of the plateau, as they likewise are concerned with the question of underground waters. Three types are recognized: "(1) small cavities within individual limestone strata, giving them what is locally termed a honeycombed structure; (2) open caverns occurring in certain bluff faces along the stream valleys; (3) underground caverns of vast extent dissolved out of many strata."

The flora is next discussed. It presents three phases: that of the stream bottoms; "that of the breaks, and that of the summit." Among the interesting facts recorded mention may be made of one: the occurrence of the cypress. "This tree, which ordinarily grows only in the swamps and bayous of the low subcoastal regions, attains an enormous size at the edge of the deeper holes near the heads of permanent water of the Pedernalis, Blanco, San Marcos, Guadalupe, Cypress, Onion Creek and other streams. These localities are at altitudes from 1,000 to 1,750 feet above the sea, and hundreds of miles west of the great cypress swamps of the eastern tier of Texan counties, with which they have no possible continuity. * * * *

"Before entering upon the geology of the region a few pages are devoted to a statement of 'the general principals of artesian waters.' Under the caption 'Capacity of Rocks for Absorbing Moisture' the following succinct statement is given concerning the water-bearing strata of Texas: "The artesian water-bearing strata of the State east of the Pecos River are composed mostly of extensive sheets of sands, clays and limestones, succeeding one another in orderly arrangement, except along the Balcones zone of faulting, and in general having a gentle inclination towards the sea, so that in travelling northwestward, although constantly

ascending in altitude, one encounters the outcropping edges of rock sheets of lower and lower stratigraphic position. This produces the simple arrangement of a tilted plain built up of a series of alternately impervious and pervious layers. The rain falling upon the outcropping edges of the latter sinks into the embed and by gravity is conducted seaward down the plain of its inclination to lower levels beneath the surface. Each different stratum, including any particular water-bearing stratum, becomes embedded deeper and deeper to the southeastward of the point where it outcrops at the surface."

The rocks appearing in the region under discussion are tabulated as follows:

"RECENT.

Wash deposits of the hillsides, stream-bed material, etc.

PLEISTOCENE.

Onion Creek marl; Leona formation, and other terrace deposits.

PLIOCENE.

Uvalde formation.

EOCENE.

CRETACEOUS.

Gulf Series.

Webberville and Eagle Pass formations	} Montana division.
Taylor and Anacacho formations.....	

Austin chalk.....	} Colorado division.
Eagle Ford shales.....	

Comanche Series.

Shoal Creek limestone.....	} Washita division.
Del Rio clay.....	
Fort Worth limestone.....	

Edwards limestone.....	} Fredericksburg division.
Comanche Peak limestone....	
Walnut formation.....	

Glen Rose formation.....	} Trinity division."
Travis Peak and allied formations.....	

Most of the above formations are minutely described, especially the Cretaceous, and many measured sections given. The carefully executed work about Austin will be extremely valuable to students, as that locality affords a most inviting field for study.

The chemical lime deposits merit a line in passing. In many parts of Texas, where the country rock is chalky, some of the calcareous matter is evidently redistributed through the

agency of rains. By the subsequent evaporation of the water a superficial cement or crust is formed which may involve pebbles distributed over the surface—this is 'tepetete.'

The igneous rocks of the Rio Grande Plain occur 'along the interior margin.' They are basic. The rock from Pilot Knob has been described as nepheline-basalt.*

The arrangement of the strata is next considered. The Cretaceous rocks are shown to have great persistency, while their dip towards the coast is but slight. The Balcones fault zone has already been mentioned as forming the 'abrupt southern termination of the Edwards Plateau.' "The strata on the seaward side of the faults have been dropped down, so that any particular stratum—the top of the Edwards limestone, for instance—lies 500 to 1,000 feet lower on the coastward or downthrow side of the fracture than on the interior or upthrow side." It should, however, be borne in mind "that the fault zone really consists of many faults, having subparallel directions all concentrated in a narrow belt of country." The displacement at Mt. Bonnell, on the Colorado above Austin, is such that the Eagle Ford shales of the Gulf series are brought in contact with the Glen Rose beds of the Comanche series.

Our authors now enter upon a discussion of the water capacity of the various rock sheets. The impervious layers are, of course, non-water-bearing, and to this class, south of the Colorado River, belong nearly all the Cretaceous rocks above the Edwards limestone. On the other hand, "rocks of open texture, such as sands, conglomerates, porous and chalky limestones, and massive rocks broken by joints, fissures, honeycombs or other openings, are usually water-bearing. These are mostly found below the Del Rio clay." The proof of the water-bearing property of the Edwards limestones is supplied by the "great springs * * * bursting out of them at the head waters of the Llano, Guadalupe, Frio and Neuces Rivers;" by the artesian well records at Manor, San Marcos and San Antonio, and by the ordinary wells of the Edwards Plateau. The distribution of water

is facilitated also by the honeycomb and cavernous character of certain limestone layers. The opinion is expressed that the Travis Peak and Gillespie formations, at the very base, contain "a greater quantity of water than any other beds of the Comanche series."

The underground water of the region is next taken up: (1) The waters of the Edwards Plateau; (2) The waters of the Rio Grande Plain. In many instances non-flowing wells, springs and artesian wells receive detailed treatment; of the latter logs are frequently given, as in the case of the Austin wells, the San Marcos well, the Manor well and those of San Antonio. Under the chemical qualities of the waters mention should be made of the excellent analyses of waters from Austin and vicinity, made by Dr. Henry Winston Harper, of the University of Texas.

Of the fissure springs, those at San Marcos, San Antonio, New Braunfels, Austin, etc., are well known. On p. 311 is given a table of the discharge of the various spring rivers, the San Marcos reaching 57,522,200 gallons in twenty-four hours, and the Comal 221,981,932 gallons in the same time. From a study of the strata and their faulting the authors conclude that "these waters come from the deep-seated rocks and are forced to the surface by hydrostatic pressure. Hence they are artesian in nature and constitute natural artesian wells." Taking into consideration the color, taste, temperature, volume, freedom from sulphuretted hydrogen, the conclusion is reached that "their water is derived from either the 'sweet water' horizon of the Edwards formation or the Travis Peak sands, that is, they have the same source as the purer waters of the artesian wells."

As to the source of the underground waters, the fact that the Pecos breaks the continuity of the strata renders it impossible, as the authors point out, to consider the Rocky Mountain region in this connection. They contend, on the other hand, that the Plateau of the Plains is the real source; that "much of the rain water is caught directly upon the edges of the Glen Rose and lower beds which outcrop along the western and northern summits, breaks and margins of the Plateau * * * at an elevation higher than that of their embedded continuation along

* J. F. Kemp. See Pilot Knob: 'A Marine Cretaceous Volcano,' by Robt. J. Hill and J. F. Kemp. *Amer. Geologist*, Vol. VI., 1890, p. 292.

its eastern and southern margin." Of the rainfall on the Edwards Plateau a large part must reach the water-bearing strata by percolating downward.

By the Balcones faulting, however, the continuity of the beds is broken on the southeast and south; hence the contained water must either escape through fissures, forming fissure springs, or be forced into the porous beds underlying the Rio Grande Plain—beds which occupy a different position in the geologic column, as, for instance, the porous Edwards limestone abutting the water-bearing Glen Rose beds.

The report is enriched with many excellent plates, not to mention maps and diagrams. Of the former, fourteen illustrate the characteristic fossils of the principal formations encountered in drilling for artesian water.

FREDERIC W. SIMONDS.

UNIVERSITY OF TEXAS.

A Handbook of Medical Climatology: Embodying its Principles and Therapeutic Application, with Scientific Data of the Chief Health Resorts of the World. By S. EDWIN SOLLY, M. D., M. R. C. S., Late President of the American Climatological Association. Philadelphia and New York, Lea Bros. & Co. Illustrated. Cl. 8vo. Pp. 470. Price, \$4.00.

This work is a systematic treatise on climate in its medical relations. It affords precise information with reference to health resorts, enabling physicians and their patients to obtain unprejudiced reports as to localities without reliance on the scattered and often unreliable data hitherto available.

The first two sections deal with the principles of medical climatology; the effect of cold; humidity; perspiration; barometric pressure; the effect of climate as seen in different races of men; and the geographical distribution of disease.

The application of climate to the treatment of phthisis forms an important chapter of seventy pages. It bears evidence of the author's large experience with this affection. The effect of climate on other organs besides the lungs is also included.

We believe it would have been wiser not to

have attempted to cover the entire globe in the treatment of this extensive subject. The portion devoted to the United States is ample so far as it relates to the Rocky Mountain Region and the Pacific Slope. It is presented in such an attractive manner that we wish that the Eastern and Middle States had been more fully exploited. At least a paragraph on Atlantic City and Cape May might well have been added, not to mention other resorts on the New Jersey coast. Bedford Springs and Glen Summit, in Pennsylvania, seem to have escaped the author's attention. In a work of this kind sins of omission are almost inevitable, and it is difficult to make the text so even as to satisfy critics from every locality. We do not know of any one better qualified to discuss the intricacies of the American climates than Dr. Solly; certainly no one hitherto has presented the subject in so attractive and useful a volume.

G. HINSDALE.

SCIENTIFIC JOURNALS AND ARTICLES.

THE first number of the *American Anthropologist*, new series, to the plans for which we have already called attention, has been issued by Messrs. G. P. Putnam's Sons. The number, which contains 200 pages and 10 plates, is made up as follows:

Powell, J. W. Esthetology, or the Science of Activities designed to give Pleasure.

Brinton, Daniel G. The Calchaqui: an Archaeological Problem.

Mason, Otis T. Aboriginal American Zoötechny.

Fletcher, Alice C. A Pawnee Ritual used when changing a Man's Name.

Boas, Franz. Some Recent Criticisms of Physical Anthropology.

Holmes, W. H. Preliminary Revision of the Evidence relating to Auriferous Gravel Man in California. (First Paper.)

Brinton, Daniel G. Professor Blumentritt's Studies of the Philippines.

Mooney, James. The Indian Congress at Omaha.

Hough, Walter. Korean Clan Organization.

Gatschet, A. S. 'Real,' 'True,' or 'Genuine' in Indian Languages.

Tooker William Wallace. The adopted Algonquian term 'Poquosin.'

Anthropologic Literature.

Current Bibliography of Anthropology.

Notes and News.

Mr. F. W. Hodge is secretary and managing editor, and the editorial board consists of Frank Baker, Smithsonian Institution, Washington; Franz Boas, American Museum of Natural History, New York; Daniel G. Brinton, University of Pennsylvania, Philadelphia; George M. Dawson, Geological Survey of Canada, Ottawa; George A. Dorsey, Field Columbian Museum, Chicago; Alice C. Fletcher, Harvard University, Cambridge; W. H. Holmes, U. S. National Museum, Washington; J. W. Powell, Bureau of American Ethnology, Washington; F. W. Putnam, Peabody Museum, Cambridge. The journal, published quarterly, at a cost of four dollars a year, deserves the support of all interested in anthropology, as it will accomplish much for the science, which is now making such great advances.

THE first article in the *American Naturalist* for March is by Professor J. P. McMurrich, on 'The Present Status of Anatomy,' various advances in the study of anatomy are described, and a strong plea made for the study of comparative anatomy as an aid to the understanding of human anatomy. Dr. Erwin F. Smith records 'The Second Annual Meeting of the Society for Plant Morphology and Physiology,' and submits abstracts of the papers presented. Professor J. S. Kingsley and W. H. Ruddick discuss 'The *Ossiculi Auditus* and Mammalian Ancestry,' deciding, as the result of their observations, that the incus has been correctly regarded as the quadrate. The probability of an amphibian origin for the Mammals is favorably considered. Professor Harris H. Wilder treats at some length of *Desmognathus fusca* (Rafinesque) and *Spelerpes bilineatus* (Green), two species often confused with each other, particularly in their larval state. The habitat and development of each is described. 'The Poisons Given Off by Parasitic Worms in Man and Animals' are briefly noted by Dr. G. H. F. Nuttall, who considers that this is a fruitful field for research. Dr. Leonhard Stejneger describes 'A Curious Malformation of the Shields of a Snake's Head,' whereby the scutellation was completely changed. Among the editorials one protests against too strict an adherence to the laws of priority. The many readers of the *Naturalist*

will note with pleasure that the table of contents is provided with page references.

THE leading article of the April *Monist* is on 'The Primitive Inhabitants of Europe,' by Professor G. Sergi, of Rome, and sets forth the criteria which this anthropologist has established for distinguishing race-types. The monumental work of Mr. Shadworth H. Hodgson, 'The Metaphysic of Experience,' is discussed at length by Dr. Edmund Montgomery. Mr. William Romaine Paterson contributes an article on 'The Irony of Jesus,' in which the intellectual and critical side of the great Teacher is emphasized. Dr. Paul Carus has a study in comparative religion, called 'Yahveh and Manitou,' in which he draws a parallelism between Yahveh, the Israelitish God of the desert, and the great deity of the North American Indians. Professor L. Lévy-Bruhl, of Paris, offers a study of 'The Contemporaneous Philosophy of France,' and Lucien Arréat his usual critical review of current French philosophical and scientific literature. The book reviews of the number deal mainly with works on the philosophy of science, mathematics, physics, and so forth.

SOCIETIES AND ACADEMIES.

BIOLOGICAL SOCIETY OF WASHINGTON, 303D
REGULAR MEETING, SATURDAY, FEB-
RUARY 25.

MR. H. J. WEBBER spoke of some recent researches in the development of *Cobæa scandens* which exhibited a hitherto unknown method of spindle formation.

The remainder of the evening was devoted to a discussion of the features of the Great Dismal Swamp. Dr. W. H. Seaman described the peculiar method of getting out lumber by digging a small ditch, just large enough to accommodate a single log. He also stated that a sample of the clay underlying the lake showed no diatoms.

Mr. F. D. Gardner presented some further remarks on the soils, saying that the reclaimed land was extremely good for raising corn, as the amount of rainfall during the critical month of August is about twice that of the Western corn belt.

Mr. F. V. Coville noted the importance of

the lake as a feeder for the Dismal Swamp canal and also as a possible source of water supply for Norfolk. The cleared land was said to be well adapted for truck farming, while the cypress and juniper lumber was also available, and the latter, being of rapid growth, could be cultivated.

Mr. William Palmer spoke further on the physiographic features of the region and of the animals, stating that the swamp lay near the northern limit of many Southern species. The Prothonotary Warbler was said to be abundant, and the manner in which the Chimney Swifts bred in the hollow cypresses was described.

Mr. Vernon Bailey noted the occurrence of such Northern forms as the Shrew, Star-nosed Mole and the Lemming Mouse.

Dr. A. K. Fisher spoke of the manner in which the sphagnum pushed out into the ditches, and drew attention to the fact that the removal of the dam at the entrance of the canal feeder would drain the lake, as the canal had been dredged out some distance from the shore.

Professor Lester F. Ward gave an account of a visit to the swamp in 1877.

O. F. Cook,
Recording Secretary.

THE WASHINGTON BOTANICAL CLUB.

THE fourth regular meeting was held at the residence of Mr. A. J. Pieters, March 1, 1899.

Mr. T. A. Williams, in discussing 'New or Interesting Lichens,' exhibited specimens of *Omphalodium Arizonicum* Tuckerm., and reported the collection of this rare lichen in the White Mountains of New Mexico, by Professor E. O. Wootton, this being the second time that the species has been obtained by collectors. The original specimens were discovered by C. G. Pringle in Arizona. The validity of the genus *Omphalodium* was discussed, and the opinion expressed that it was abundantly distinct from *Parmelia*. Specimens were also shown of four new species of lichens belonging to the genera *Siphula*, *Lecanora*, *Gyalecta* and *Omphalaria*, with comments on their distinguishing characters and relationships.

Mr. Frederick V. Coville gave a systematic review of 'The Currants and Gooseberries of Southeastern Oregon,' exhibiting many speci-

mens and explaining the differentiation of species from aggregates, such as *Ribes divaricatum* and *R. lacustre*.

Mr. Pieters exhibited a gigantic specimen of *Lophotocarpus calycinus* from the shores of Lake Erie, commenting on its eastern extension.

CHARLES LOUIS POLLARD,
Secretary.

THE NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY.

THE regular monthly meeting of the New York Section of the American Chemical Society was held on Friday evening, the 10th inst., at the Chemists' Club, 108 West Fifty-fifth street, Dr. Wm. McMurtrie presiding and eighty-five members present. Dr. Doremus made a special announcement of the annual exhibition of the New York Academy of Sciences, and urged any members having new and interesting material to contribute the same to the exhibits.

The following papers were then read:

1. Frederick S. Hyde, 'Preparation of Graphitoidal Silicium.'
2. W. O. Atwater, 'The Conservation of Energy in the Human Body.'
3. Joseph F. Geisler, 'Paraffin as an Adulterant of Oleomargarine.'
4. L. H. Reuter, 'Manufacture of Pure Phenylmethylpyrazolon-sulphonic Acid.'
5. L. H. Reuter, 'Manufacture of B Naphthalene-sulphonic Acid and Benzoyl-sulphonic Acid for the Manufacture of Ether.'
6. A. Bourgougnon, 'On the Determination of Sulphur in Sulphites.'

While the first paper was before the meeting, the President of the Society, Professor E. W. Morley, of Cleveland, arrived, and was invited to take the chair. He made a few remarks on the interest taken in the Section by its members, as evidenced not only by the full attendance and interesting list of papers to be read at this meeting, but by the uniformly high character and abundance of material announced for each and every meeting.

Professor Atwater stated that the large calorimeter chamber, in which a man can live for a week or more at a time, has been so perfected that an analysis of pure alcohol by combustion can be made in it to within 0.1 per cent. of the

theoretic composition. The results on the caloric value of foods as consumed in the human body agree very closely with the results calculated from experiments with the bomb calorimeter. The chief difficulties at present are in regard to certain constants, as, for instance, the value of the calorie, the latent heat of evaporation of water at different temperatures, etc. The calculation of the observations from a week's run of the calorimeter chamber is itself an arduous and exacting piece of work. Thus far the law of the conservation of energy in the human body is fully demonstrated, within a very small error, which it is hoped to eliminate entirely.

J. F. Geisler exhibited a sample of paraffine extracted from adulterated oleomargarine, which contained about 45 grains of the wax per ounce.

Samples had been purchased in New York and vicinity containing from 5 to 11.75 per cent. paraffine.

DURAND WOODMAN,
Secretary.

SECTION OF ASTRONOMY AND PHYSICS OF THE
NEW YORK ACADEMY OF SCIENCES,
MARCH 6, 1899.

ANNUAL election of officers was held, and Professor M. I. Pupin elected Chairman, and Dr. W. S. Day, Secretary, to serve for the ensuing year.

Professor J. K. Rees described the great horizontal telescope for the Paris Exposition in 1900. This instrument is to have a focal length of 66 meters, and is placed horizontally, on account of the great difficulty of building and moving a dome large enough for it, if mounted in the usual manner. A plane mirror is mounted so as to be capable of motion in any direction, in order to reflect the light of a star into the tube. The object glass is 49 inches in diameter. A number of lantern views of the Yerkes telescope were shown. This, when the Paris instrument is completed, will no longer be the largest in the world.

Dr. P. H. Dudley read a paper entitled: 'Stresses in Rails due to Thermal Changes,' in which he showed that most fractures of rails occur on a decided fall of temperature, because the rails, held very tight by the bolts in the

splice bars, are strained by the contraction beyond their tensile strength; while on a rise of temperature the expansion of the rails puts them under a stress of compression; and apparently the factor of safety of the steel is not so much reduced under compressive as under tensile stresses.

R. GORDON,
Secretary.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

At the meeting of the Academy of Science of St. Louis on the evening of March 20, 1899, fifty-three persons present, Dr. T. J. J. See delivered an address on the 'Temperature and Relative Ages of the Stars and Nebulæ.' The address, which developed quite fully the temperature equation, was discussed at some length by Professor C. M. Woodward. A paper by Professor L. H. Pammel, on 'Anatomical Characters of the Seeds of Leguminosæ,' was presented by title.

Two persons were elected to active membership.

WILLIAM TRELEASE,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

PLYMOUTH, ENGLAND, AND ITS MARINE
BIOLOGICAL LABORATORY.*

PLYMOUTH is a place of great natural beauty and more undulating than any city with which I am familiar. It has a population of about 200,000 and is a seaport of much importance, many of the Oriental and Australian steamships touching here. It contains one of the largest navy-yards and garrisons in England. In one respect it is unique, as far as my experience goes, for the city touches the harbor at its eastern and western extremities only, the central part being separated from the water-front by a high open hill called Hoe Park. The rising face of this hill is tastefully laid out as a park, while on the summit is an asphalt promenade 150 feet wide and extending for half a mile.

* In a recent private letter to a friend, Dr. Edward G. Gardiner gives an account of Plymouth, its Laboratory, its winter climate and other matters, which it is believed many readers of SCIENCE will be glad to have for reference.

From this high platform the land falls rapidly toward the sea, but the grassy slope is broken here and there by terraced paths and drives and the sea breaks at the base on rugged limestone cliffs. Nestled among the nooks and crannies of the rocks are various public bath-houses, and until the end of November numerous bathers might be seen diving, swimming or sunning themselves like seals on the rocks. These rocks constitute a most beautiful piece of cliff scenery, and from the top of the promenade the view is magnificent. Northward lie the hills of the city and beyond these the wild uplands of Dartmoor; to the south, at one's feet, lies the harbor with all its busy shipping, red-sailed fishing craft and strange looking warships. The harbor, or 'sound,' as it is called, is a bay, roughly speaking rectangular in shape, some three miles deep and about as broad, bounded by headlands upwards of four hundred feet high, falling abruptly, and in many places precipitously, to the sea.

Official documents state that the defences of this sound include fourteen miles of fortifications, and as many of these are on the headlands their towers, angles and projections break the sky line and add interest and beauty to the scenery. The entrance to the sound is protected by a breakwater (on which is a lighthouse and a fort) a mile in length, thus converting what must have been but a wild and dangerous anchorage into a safe harbor. A few days ago we had a southwester which broke the record. The harbor was full of shipping, and it was interesting to stand on the Hoe in a sheltered place and see the havoc. A good deal of damage was done, but no lives were lost. The word 'Hoe,' I am told, is an old name for 'Hill,' and is common along this coast, for example, Plymouth Hoe, School Hoe, Stedcombe Hoe, Mort Hoe, Croyte Hoe, Martin Hoe, etc., along the coasts of Devon and Cornwall. Moreover, there are numerous 'Holes' along this coast, Rent's Hole, Croft Hole, Mouse Hole, Hole's Hole, Butter Hole, Daddy Hole, Kent's Hole, etc. Speaking without any philological knowledge whatsoever, I more than suspect that 'Hoe' and 'Hole' may originally have been the same word, though I have not found any very competent authority

on which to rest such a theory. What first suggested it was the fact, generally accepted hereabouts, that Hoe means hill, and in the discovery that at least two of the above-mentioned Holes were hills where there are no 'holes' (or harbors) in the land. Whatever the origin of Hole may be, it is interesting to note that both Hoe and Hole are 'west-country' names, *i. e.*, belong to Devon and Cornwall. The only 'Holes' on the New England coast, so far as I know, are in southern Massachusetts, and in that part of the State are also Plymouth, Falmouth, Dartmouth, Truro, etc., all Devon and Cornish names, and the association of these with Wood's Hole, Holmes' Hole (now Vineyard Haven), Quick's Hole, and the like, is interesting.

Directly under the walls of an old iron-clad fortress which crowns the southern end of the Plymouth Hoe stands the Laboratory of the Marine Biological Association of Great Britain. Between the Laboratory and the fort—a distance of fifty yards—are a garden and tennis-court, while the sun reflected from the limestone wall beyond has all the value for microscopic work of a white cloud perpetually anchored in the right place. Those who built the fort did not know what good work they were doing for naturalists. On the other side of the Laboratory the land falls away abruptly to the sea. The designers of the Laboratory building had no idea, however, of exposing the naturalist when armed with dip-net and bucket for a collecting trip to the gaze of the curious public, for a cleverly constructed tunnel leads from the basement under the foot- and driveway directly to the cliffs whence a path winds downwards to the boat-landing and the beach.

The Laboratory building is a handsome stone structure 179 feet long. The central part, 70 x 34, is two stories in height, while at each end the remaining portion is higher and broader, thus giving an effect of low, flanking towers. In one of these towers is the residence of the Director, while in the other are rooms for the engineer, caretaker, etc., on the lower story, and in the second, chemical laboratories and supply department, with the library above in the third story. The library is a charming room, having two open fireplaces and offering a view which is so attractive as seriously to interfere with hard

work. The library contains about 1,500 volumes, and it is not difficult to obtain books from elsewhere when necessary.

On the ground floor of the central portion of the building is an aquarium well stocked from the native fauna and open to the public for a small fee. Above the aquarium is the main Laboratory, a well-lighted and well-ventilated room of moderate height, 70x34. The windows, which are very large, are separated by partitions about seven feet high, forming a series of alcoves, each about ten feet square. Through the center of the Laboratory runs a continuous line of aquaria designed for experimental work. The whole place is clean, orderly and well kept (except, of course, my own alcove), and as good a place for work as could be desired. Every investigator is given a pass-key to the Laboratory, which is available for work day or night and every day precisely as one wishes or as his work requires. Smoking is allowed everywhere, which is a luxury to me, for you may remember that an occasional cigarette is necessary for my health.

The staff consists of three naturalists, including the Director, and eight employees, such as janitor, boatman, Laboratory *Diener*, etc. The latter is well trained in the art of preserving marine animals in the expanded condition, in the art of mixing reagents, and the like. The Laboratory is provided with a steamer about 60 feet long and with a sail-boat, both of which are kept well employed collecting for the supply department, so that there is an abundant supply of fresh material constantly brought in. In the Official Reports of the Laboratory stress is naturally laid on its needs. Some with whom I have talked have seemed to interpret these appeals as signifying extreme poverty, and are surprised accordingly to find an establishment so well equipped. It is not, of course, perfect, but, in my opinion, it is an excellent laboratory, admirably managed.

In the university vacations the place, I am told, is full of workers, but during the present winter there have been in residence only the three naturalists on the staff and three other investigators besides myself.

I have read of the severe winter at home with many chuckles of satisfaction that I am not in

it, for, as you know, I have no affection for our blizzards, and I am contented that they are unknown here. The lowest temperature recorded this winter at Plymouth was 29° F. on what the newspapers called a 'bitter cold night,' and the highest during January was 56°. As a rule, it has been 45° or thereabouts. We have a good deal of rain, but, by a fortunate meteorological arrangement, it is rarely cold and stormy at the same time. The south and southwest winds are mild and rainy and the easterly and northerly winds clear and cool. The winds are so tempered that sheep graze in the public parks all winter, while on tennis-courts, and on lawns where sheep are not allowed, lawn-mowers have been in constant use to keep the grass under control. Many of the more hardy garden plants bloom all winter, and the ivy and numerous shrubs are luxuriant with greenness. Spring is already at hand (February 17th), as is apparent from the wild violets and primroses, blossoms of which I have picked in the fields this week. One day it snowed for two hours, but at the end of that time there was no snow to be seen, every flake having melted as it fell.

Of course, the people exercise the right of all free men to grumble at the weather, but I have seen many climates which gave far more cause for grumbling. There is a widespread impression, which I suspect may be correct, that the big storms here are hatched on our side of the Atlantic and find their way across. Whenever we get a good strong southwester people say with an injured air, 'See how the Americans treat us,' almost as if there were personal spite in it. On the whole, the climate is to me infinitely more agreeable than that of New England.

To sum it all up, Plymouth and its surroundings are beautiful; the climate is (to me) agreeable; my family has been in most excellent health all winter; and, lastly, the Laboratory is a most delightful place for work.

THE DUPLICATION OF GEOLOGIC FORMATION NAMES.

THE custom of giving more or less local geographic names to geologic sub-divisions has become so universal that we are even now duplicating the use of such names to a considerable

extent. Geological literature is of too great bulk for the working geologist to attempt to ascertain whether or not names which he proposes to use have been preoccupied. To illustrate what the present system is leading to, a few instances of some prominence will be cited.

In 1883 Hague described, in a report of the U. S. Geological Survey, the Eureka quartzite, a sub-division of the Silurian, in the Eureka district, Nevada. In 1891 Simonds and Hopkins, in a report of the Arkansas Geological Survey, used the name Eureka shale for a supposed Devonian horizon; while in 1898 Haworth, in a report of the Kansas Geological Survey, proposes the name Eureka limestone as a sub-division of the Coal Measures.

In 1879 Peale, in the 11th Annual Report of the U. S. Geological and Geographical Survey of the Territories, employed the term Cache Valley Group for a sub-division of the Pleistocene of Utah. Becker described, in 1888, the Cache Lake beds of California, in Monograph XIII of the U. S. Geological Survey, and referred them to the Tertiary. In 1896 G. M. Dawson, in a report of the Canada Geological Survey, uses the name Cache Creek formation for an horizon of the Carboniferous to include strata described by Selwyn in 1872 as Upper and Lower Cache Creek beds.

In 1842-46 Emmons, Vanuxem and Mather employed, the term Erie division as a sub-division of the New York system. In the Ohio Geological Survey reports, the Erie clay was used as a sub-division of the Pleistocene, and Erie shale was referred both to the Carboniferous and Devonian. In 1875 Lesley described, in a report of the Pennsylvania Geological Survey, the Erie shale, which he referred to the Silurian. In 1898 Haworth described the Erie limestone of the Coal Measures of Kansas. The above references are given merely to illustrate the confusion that is likely to arise from use of new geographic terms if the literature is not carefully examined for previous use.

For the past eighteen months the writer has been engaged in preparing a card catalogue of geologic formation names, during such time as could be taken from other office and field work. This catalogue has already assumed considerable proportions, and is now being consulted by

those geologists who are aware that such a work is being prosecuted. While preparing the annual bibliography of geological literature for 1898 the writer has found several instances of duplication of names that have become well established in geologic nomenclature. It will probably be a year or more before this catalogue can be published, and, in the meantime, to assist in avoiding such duplication, the writer offers to furnish geologists who will correspond with him such information as he possesses regarding names which they propose to use as formation names.

F. B. WEEKS.

U. S. GEOLOGICAL SURVEY,
WASHINGTON, D. C.

THE BERLIN TUBERCULOSIS CONGRESS.*

THE German Central Committee for the erection of Sanitaria for Consumptives have issued a call for a Congress to be held in Berlin, Germany, May 24-27, 1899, for the purpose of discussing the subject of tuberculosis. The Congress will meet in the new building of the Imperial Diet and is under the patronage of Her Majesty, The Kaiserin, while Prince Hohenlohe, the Imperial Chancellor, will serve as Honorary President. All of the German States, also local authorities, medical faculties and societies, and all corporations interested in fighting tuberculosis, have been requested to send delegates, and all foreign countries represented at the Imperial Court have also been invited to take part. The United States Embassy has been requested to extend a cordial invitation to American physicians to become members of the Congress, and the same invitation has been extended through other missions to physicians of other nationalities.

As a basis for discussion papers will be presented as follows: (1) 'Distribution and extent of tuberculosis' by Geheimrath Koehler, Director of the Imperial Health Office, and Geheimrath Krieger, of Strassburg; (2) 'Etiology,' by Professors Robert Koch and B. Fraenkel, of Berlin; (3) 'Prophylaxis,' by Pro-

* Written at the request of Dr. Pannwitz, General Secretary of the Congress, and forwarded simultaneously to several American journals. The medical, veterinarian and scientific press is requested to call the attention of its readers to this Congress.

fessor Gerhardt and Generaloberarzt Schjerning, of Berlin; (4) 'Therapy,' by Professor von Ziemssen, of Munich, and Professor Schroetter, of Vienna; (5) 'Sanitaria,' by Herr Gaebel, President of Imperial Insurance Office, Berlin, and Dr. Dettweiler, of Falkenstein.

Following the presentation of the two leading papers (limited to 20 minutes each) in the respective divisions, there will be a general discussion, speakers being limited to 10 minutes each. All papers and remarks are to be in German, although the chairman is empowered to make exceptions during the general discussion.

All persons interested in the subject of tuberculosis are eligible for membership; membership cards (20 Marks, nearly \$5) are to be obtained at the office of the Congress ('Bureau des Organisations-Komites, Wilhelm Platz 2, Berlin, W') and entitle the holder to a copy of the 'Proceedings.' An early registration is requested.

The writer has been requested to furnish a list of Americans to whom special invitations to the Congress should be sent. He has complied with this request, so far as his personal and professional acquaintance with specialists in this line has permitted, and has also suggested to the committee that invitations be sent to the various medical societies and faculties. There are undoubtedly many American practitioners especially interested in tuberculosis and possibly some laboratory workers whom he has overlooked. Should any such person desire to attend the Congress, yet prefer to receive a personal invitation, the writer will be pleased to forward the name of such persons, upon proper introduction, to the Executive Committee of the Congress. As 'proper introduction' will be considered a letter from any recognized medical, scientific or veterinary faculty or society.

CH. WARDELL STILES, PH.D.,
Scientific Attaché, U. S. Embassy, Berlin, Germany.

ASTRONOMICAL NOTES.

THE RUTHERFURD PHOTOGRAPHS.

AMONG recent additions to the literature of the astronomy of precision are four contributions from the Observatory of Columbia University which give the results of measurements of the Rutherford plates. Dr. Davis contributes

three of these, entitled 'Catalogue of Sixty-five Stars Near 61 Cygni,' 'The Parallaxes of 61¹ and 61² Cygni,' 'Catalogue of Thirty-four Stars near Bradley 3077.' Mr. Schlesinger contributes the fourth, upon 'The Præsepe Group.' All these are most admirable illustrations of the highest type of astronomical work in the determination of exact positions of the stars, and careful deductions therefrom. No pains have been spared to make the original measures under such conditions that the instrumental constants shall be well determined, and all corrections and reductions accurately applied. The result is three catalogues of stars whose coordinates relative to the reference star in each group are determined with great precision. The two catalogues of stars near 61 Cygni and Bradley 3077 are for the purpose of discussing the parallaxes of these well-known stars. The most interesting result of Dr. Davis's discussion is the well-marked difference of parallax between 61¹ and 61² Cygni, determined from both position angles and distances, the numerical amount of which is $0''.072 \pm 0''.028$. This large difference, if real, explains the failure of double-star observers to detect any evidence of orbital motion, and would show that the stars do not form a binary system. A confirmation of this conclusion is found in a careful discussion of Wilsing's determinations of the distance of these two stars, which gives $0''.0876$ for the difference. The mean of the different determinations of parallax for the stars made by other astronomers shows a difference of $0''.082$, which confirms further the reality of the result. The author urges the making of a more extended series of comparisons by photography to give further evidence on this subject.

An interesting result of Mr. Schlesinger's study of the measures of the Præsepe stars is that the method of orienting the plate by the method of trails is not as accurate as that based upon assuming the coordinates of several comparison stars on the plate, as determined by the meridian circle or the heliometer. It was Mr. Rutherford's rule to make two impressions of the regions photographed, stopping the clock for a few seconds between them, and also to give a third impression of the brightest stars by stopping the clock about three minutes and

making a brief exposure. In this way each plate contains its own data for orientation. The author thinks that the somewhat large discrepancies between this method and that by meridian circle observations is due to the jarring of the plate by stopping and starting the clock. Its value as an independent method, however, is recognized.

THE SOLAR ECLIPSE OF MAY 28, 1900.

THE committee appointed at the recent conference of astronomers and astrophysicists to consider the observations to be made at this eclipse has issued a circular letter asking for opinions as to the observations deemed advisable and what cooperation our American astronomers can render. The eclipse path extends from the Gulf coast to the Atlantic, but the duration of totality is short, only $1^m 13^s$ near New Orleans and $1^m 40^s$ near Norfolk, Va., according to the circular. The figures given by the circular of the English Nautical Almanac are a few seconds larger than these, $1^m 17^s.8$ west of New Orleans, and $1^m 45^s.6$ south of Cape Henry, Va. Some excellent points of observation may be found in Portugal and Spain, where the totality will range from $1^m 34^s$ to $1^m 19^s$. European astronomers are likely to locate at this end of the line. American observers should cover thoroughly the path through the United States, which includes many places readily accessible. The U. S. Weather Bureau has issued a second bulletin upon the probable weather to be expected. This is based upon special reports made in May, 1898, the former report including those of 1897. A third report for 1899 is promised. The conclusion thus far is that the most unfavorable weather is to be expected on the Gulf and Atlantic coasts, and that the most favorable locations are in the northern parts of Georgia and Alabama, upon the southern end of the Appalachian Mountains.

WINSLOW UPTON.

PROVIDENCE, R. I., March 15, 1899.

NOTES ON PHYSICS.

THE EFFECT OF COMMUTATION ON THE FIELD OF DYNAMOS AND MOTORS.

MESSRS. EVERETT AND PEAKE, in a paper on 'The Effect of Commutation on the Field of

Dynamos and Motors' in the *London Electrician* of December 30, 1898, find, by means of an exploring coil and instantaneous contact maker, that the effect of commutation is to produce somewhat regularly recurring ripples in the curve connecting E. M. F. and position of the exploring coil, the maximum of the ripples occurring at intervals equal to the width of a coil, decreasing in magnitude as the distance from the commutated coil increases and nearly disappearing before the interpolar gap is passed. These ripples were found to be more marked with narrow than with wide brushes, which is explained by the damping effect of the adjacent short-circuited coils acting as secondaries to each other. The ripples are also more marked for heavy than for light currents and for motors than for dynamos.

TELEGRAPHY AND MAGNETIC INDUCTION.

S. EVERSLED, in an article on 'Telegraphy by Magnetic Induction' in the same journal, deduces a formula for the mechanical energy available in a distant secondary circuit in which no capacity is used, in terms of dimensions, resistance, frequency, etc., and from this calculates that in the case of two circuits using together 1,000 kgm. of wire, each 1,000 meters square and 10 kilometers apart, with a frequency of 100 and 100 watts in the primary, there would be available in the secondary .34 ergs. per second. Experiment shows that 2.9×10^{-6} amp. gives easily readable Morse signals in an ordinary telephone, this being double the audible current (this presumably for a frequency of 400). He then finds that in the above case, but with frequency equal to 400, there is 12×10^{-6} amp., and that hence the readable signals could be produced with 250 kgm. of copper. For satisfactory audible signals the frequency must be at least as high as 400, and here the undetermined effect of absorption of these waves by the material of the earth comes in. If this proves serious it may be necessary to use lower frequencies and other forms of receivers. A receiver is described consisting of a tuned rectangle of wire, vibrating in a strong field, or, better, two rectangles vibrating synchronously, but in opposite directions. Such instruments are being used at Lavernock and Flat Holm as

relays to close call-bell circuits. They are of iridio-platinum wire, 3 mils diameter and 2 by 4 cm. dimensions; they have a frequency of 16 per second, and with a clearance of 2 mils .001 erg. per second is required to bring them into contact. This can be used at a distance of 10 kilometers with $\frac{1}{2}$ ton of copper and would be little affected by the absorption; it has not, however, been adapted to the transmission of Morse signals. The power used by the telephone is more than 600 times the power used by the rectangle in this case. F. C. C.

THE BEQUESTS OF THE LATE PROFESSOR MARSH.

THE will of the late Professor Marsh leaves his entire estate to Yale University, with the exception of \$10,000 to the National Academy of Sciences. Its provisions are as follows: 1. The library which he had collected is to be placed in the Yale library, and all duplicates are to be given to the library of the Peabody Museum. 2. His home and the land surrounding it, nearly three acres on Prospect Hill, is given to the University to be used exclusively as a botanical garden 'and for no other purpose.' The garden is to be under the custody of a regularly appointed curator at a salary of \$2,000. The house is either to be used as the residence of the curator or as a botanical laboratory, as his executors may see fit. In case the corporation does not wish to accept the house and grounds for this purpose Professor Marsh orders that they be sold and the proceeds added to the residuary estate. 3. His executors are ordered to sell all his pictures, paintings, furniture, bric-à-brac, silver and Oriental collections, the proceeds to be turned over to the University. 4. The gift is made to the University of a collection of 2,000 orchids and of all of his greenhouse plants. If not needed by the University these may be sold for the benefit of the estate. 5. The bequest is made of all of his scientific collections in paleontology, geology, zoology and archæology, to be kept in Peabody Museum. 6. He gives to the National Academy of Sciences of Washington \$10,000 as a trust fund, 'the income to be used and expended for promoting original research in the natural sciences.' 7. The sum of \$30,000 which, by the

terms of the will of George Peabody, Professor Marsh was authorized to dispose of in his will, is left to the corporation of Yale 'to be expended by the trustees of Peabody Museum in preparing for publication and publishing the results of my explorations in the West.' 8. All the rest, residue and remainder of the property and estate real and personal, is given to Yale University to be used and expended by it for 'promoting original research in the natural sciences.'

The value of Professor Marsh's estate is said to be about \$100,000, but may not prove to be as much. It will be remembered that somewhat more than a year ago Professor Marsh gave his extremely valuable collections in paleontology and other sciences to the University. It is estimated that these were secured at a cost of about \$250,000. The Peabody Museum was given by Mr. George Peabody, Professor Marsh's uncle, through his influence. It should also be remembered that Professor Marsh never accepted any salary from Yale University.

SCIENTIFIC NOTES AND NEWS.

THE first Hodgkins gold medal given by the Smithsonian Institution has been conferred on Professor James Dewar, F.R.S., for his work on the liquefaction of air.

PROFESSOR HELMERT, of Berlin, has been elected a foreign correspondent of the Paris Academy of Sciences for the Section of Geography and Navigation. In the same section Père Colin, founder and director of the observatory at Tananarivo, Madagascar, was elected a corresponding member.

THE Paris Academy of Medicine has awarded its Lecaze prize (10,000 fr.) to Dr. Widal for his serum method of diagnosing typhoid fever.

It is proposed, says the *London Times*, that a portrait of the late Dr. John Hopkinson should be placed in the Hopkinson Memorial Wing of the Engineering Laboratory at Cambridge University, the cost to be defrayed by subscription. A chimney piece which Mrs. Hopkinson has presented for use in one of the principal rooms contains a panel in which such a portrait could appropriately be placed. Mr. T. B. Kennington, who painted a portrait of Dr. Hopkinson some years ago, has suggested that instead of simply

copying that picture he could produce a better representation of Dr. Hopkinson as he was shortly before his death by painting an original portrait based on a recent excellent photograph and following the coloring of the previous portrait. Subscriptions are limited to two guineas, in the expectation that a considerable number of Dr. Hopkinson's friends not resident in the University, as well as residents, will wish to contribute. Among those who have already subscribed are the Vice-Chancellor, the Master of Peterhouse, the Master of Trinity, Sir Benjamin Baker, Sir J. Wolfe Barry, Sir Frederick Bramwell, Sir Douglas Fox, Sir James Kitson, Sir G. G. Stokes, Sir William White, Lord Kelvin, Lord Rayleigh and Lord Lister. Professor Ewing is treasurer of the fund, and he will receive subscriptions, or they may be paid to the Hopkinson portrait account at Barclay & Co., Cambridge.

THE statement sent from Washington to the press to the effect that Dr. Thomas J. See had been designated Chief of the Nautical Almanac is incorrect. Dr. See has been assigned to duty as Assistant in the Naval Observatory, but has nothing whatever to do with the Nautical Almanac office.

THE funeral services of the late Professor Marsh were held in Battell Chapel, Yale University, on March 22d. President Dwight conducted the ceremonies, and Professor George F. Fisher, of the Theological School, read the commemorative address. The pall-bearers were Charles D. Walcott and Arnold Hague, of Washington; Professor Asaph Hall, Cambridge; Professor H. A. Barker, University of Pennsylvania; and Professors William H. Brewer, Addison van Name, Edward S. Dana and Mr. George F. Eaton, of Yale.

DR. PHILIPP J. J. VALENTINI, a student in ancient Mexican and Central American history, and author of numerous publications, died March 16th, at St. Luke's Hospital, New York. Dr. Valentini's interpretation of the Mexican Calendar Stone placed him among the foremost American archaeologists. He was born in Berlin in 1828, and received a careful training in philology from his father, an Italian teacher of languages and author of the first German-

Italian dictionary. In 1854 Dr. Valentini went to Costa Rica, and there founded the seaport of Puerto Limon under government auspices. Learning of the obscurity of the Spanish colonization of Costa Rica, he returned to Germany to search for manuscript historical evidence. His first results in this line brought for him the recognition of Ph.D. from Jena. Later Dr. Valentini returned to Central America, where, continuing his investigations, he made many expeditions to Guatemala and other parts of Central America. In this work he received government encouragement, but political disturbances prevented his Spanish and German texts from being published by the government. Recognizing that to thoroughly understand Spanish conquests the pre-Columbian peoples must be studied, he began work upon the glyphs of the stone monuments and codices. Thirty years ago he came to New York to make use of the greater library facilities here, and since that time has been prominent among students of Americana. The American Antiquarian Society of Worcester has published many of his papers. His most recent publication is 'A Study of the Voyage of Pinzon,' printed in German in 1898. The major part of his notes and MSS. remain unpublished.

HARLAN I. SMITH.

DR. OLIVER MARCY, professor of natural history in Northwestern University, and dean, died at Evanston, Ill., on March 19th. He was a Fellow of the Royal Geographical Society, a member of the American Ornithologists' Union, and of other scientific societies.

PROFESSOR GUSTAV WIEDEMANN, professor of physics and chemistry in the University of Leipzig, well known for his contributions to electricity and magnetism, has died.

MAJOR J. EVANS, professor of pathology in the Calcutta Medical College, died on March 13th from the plague. He is believed to have contracted the disease while engaged upon the *post-mortem* examination of a plague patient.

AMERICAN men of science should see that the decimal system of weights and measures is maintained in Cuba, Porto Rico and the Philippines. It is the first principle of colonial gov-

ernment to respect the customs of the native peoples, and we certainly should not fail to do this in a case where their customs are better than our own.

AN appropriation of \$170,000 has been passed by the Massachusetts House for the extermination of the Gypsy moth.

THE German Reichstag has made a grant of 60,000 Marks for Professor Robert Koch's approaching expedition to the tropics to investigate the nature and origin of malaria.

IT is said that Mr. Andrew Carnegie is prepared to give the Pittsburg Carnegie Library \$1,000,000 endowment and \$500,000 additional for improvements when the city authorities have appropriated \$3,500,000 for Shenly Park.

By the death of Mrs. A. H. Colson a bequest of \$25,000 for the library of Stafford, Conn., becomes available.

THE Ohio State University announces for the summer of 1899 the maintenance of a lake laboratory at Sandusky, the purpose of which is to provide laboratory facilities to any who may wish to engage in the study of the numerous forms of life there accessible. No courses of instruction are designed and no laboratory fees are charged, the special purpose being to provide opportunities for investigation. Still, the opportunities for mutual improvement among a circle of earnest workers, by comparison of methods, discussion of results and exchange of ideas, are too evident to need mention. The variety of life accessible is unsurpassed, as the lake, river, extensive bays and marshes afford a basis for life conditions of great richness. The laboratory is provided with tables, aquaria, boat and other essentials, and necessary seines, dredges, nets, etc., will be available when needed. Rooms and board may be had convenient to the laboratory at very moderate prices, and as, aside from the attractive locations along shore, the beauties of Kelley's, and Put-in Bay Islands are readily accessible by boat the opportunities are most favorable to combine a few weeks of earnest study with the recreations of a summer outing. Each investigator will be expected to provide his own microscope, microtome and such special appliances as he may need in his particular investi-

gation, unless otherwise arranged, but will be supplied with the usual reagents, glassware, etc., and will be given entire freedom in the matter and method of his investigation, except for such necessary arrangements concerning use of boat, assignment of table aquaria, etc., as may be necessary to secure equal advantages to all. The laboratory will be open from June 15th to August 15th, or, possibly, till September 1st, if desired by a number of workers. Advanced students, instructors or any persons qualified to use the facilities offered are cordially invited to avail themselves of the opportunity here provided. Further particulars may be had by addressing Professor Herbert Osborn, Department Zoology and Entomology, Ohio State University, Columbus.

UNIVERSITY AND EDUCATIONAL NEWS.

WE recently announced that Mr. Robert S. Brookings had offered to give \$100,000 to Washington University, St. Louis, on condition that \$400,000 be subscribed by others. This sum has now been given and the \$500,000 has been added to the endowment fund of the undergraduate department. This is in addition to the \$450,000 given for buildings within the past six weeks as described recently in this JOURNAL.

THE Woman's College, of Baltimore, will receive between \$25,000 and \$50,000 as the residuary legatee of the late George R. Berry, of that city.

THE Teachers' College, Columbia University, will erect, at a cost of \$350,000, a building for its model school, the Horace Mann School. This will give, in its present buildings, more ample accommodations for the regular courses.

SIX new scholarships of \$100 each have been established in the Sheffield Scientific School of Yale University. They will be awarded to members of the graduating class who stand highest in scholarship.

MR. W. J. BLANKINSHIP has been appointed professor of botany in the Agricultural College of Montana.

MR. R. C. MACLAURIN, Fellow of St. John's College, Cambridge, has been called to the chair of mathematics in Victoria College, New Zealand.

SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; J. LE CONTE, Geology; W. M. DAVIS, Physiography; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; HENRY F. OSBORN, General Biology; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; J. McKEEN CATTELL, Psychology; DANIEL G. BRINTON, J. W. POWELL, Anthropology.

FRIDAY, APRIL 7, 1899.

CONTENTS:

<i>The Fresh-Water Biological Stations of the World:</i> PROFESSOR HENRY B. WARD.....	497
<i>Brunisure of the Vine and other Plants:</i> DR. ALBERT F. WOODS.....	508
<i>An Automatic Mercury Pump:</i> DR. RALPH R. LAWRENCE.....	510
<i>Scientific Books:—</i>	
<i>Wallace on the Wonderful Century:</i> PROFESSOR W. K. BROOKS. <i>Hueppe's Principles of Bacteriology:</i> H. W. C. <i>Hoskins on The Elements of Graphic Statics:</i> PROFESSOR FREDERICK N. WILSON. <i>General. Books Received</i>	511
<i>Scientific Journals and Articles</i>	517
<i>Societies and Academies:—</i>	
<i>Chemical Society of Washington:</i> WILLIAM H. KRUG. <i>Geological Conference and Students' Club of Harvard University:</i> J. M. BOUTWELL. <i>Torrey Botanical Club:</i> E. S. BURGESS.....	517
<i>Discussion and Correspondence:—</i>	
<i>Some Suggestions for Scientific Seminars and Conferences:</i> PROFESSOR RICHARD E. DODGE. <i>A Remarkable Sun-dog:</i> PROFESSOR H. L. OSBORN. <i>Degrees in Science at Harvard University:</i> PROFESSOR J. McKEEN CATTELL.....	520
<i>Scientific Appointments under the Government</i>	523
<i>Scientific Notes and News</i>	524
<i>University and Educational News</i>	528

MSB. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

THE FRESH-WATER BIOLOGICAL STATIONS OF THE WORLD.*

AWAY back at the beginning of the investigation of minute forms of life, which followed upon the invention of the microscope,

* Annual address of the President before the Nebraska Academy of Sciences at Lincoln, November 25, 1898.

or shall I say discovery, for it seems to have been historically an accident, the early students searched the ditches and ponds and lakes for the organisms which constituted the objects of their study. Anton von Leeuwenhoek, whose name is familiar to you as one of the most zealous early workers among microscopic objects, enriched science by a long series of new organisms of this character. Roesel von Rosenhof, whose careful investigations on various fresh-water animals, published under the title of 'Insect Diversions' are still standard sources of information concerning the habits and structure of these forms, together with Swammerdam, Trembley, O. F. Müller, and a whole host of others, devoted their attention almost exclusively to the fresh-water fauna. But this movement seems to have culminated with the appearance, in 1838, of Ehrenberg's famous volume 'The Infusion Animalcules as Complete Organisms.'

Extended investigations had already impressed zoologists with the richness of the marine fauna. Numerous animal groups of common occurrence in the sea were apparently entirely wanting in fresh water, and the astounding richness of the sub-tropical and tropical oceans with which the European investigators came early in contact on the shores of the Mediterranean, and in the expeditions to the new lands of the Tropics, entirely over-

shadowed the life that had hitherto been found in pond or ditch. It is, in my opinion, also no small factor that many of the marine forms which were brought to the attention of scientists were dazzling in their beauty of form and in the brilliancy of their coloring. The quieter, more unassuming forms of lacustrine life in temperate regions could make no corresponding impress on the minds of the observers. So the scientific world went to the sea-shore for study and everywhere along the coast of Europe, and even in the islands of the Tropics were to be found the vacation resorts of scientists.

This diversion of attention from the study of fresh-water life was undoubtedly aided by the fact that fifty years ago all centers of education and investigation were comparatively close to the ocean, and so it was easy for the scientist to reach the point, where, as he had learned from the reports of others, life was most abundant and varied, and at the same time, appealed to his æsthetic sensibility as nothing did that he saw about him. The concentration of interest on the life of the sea led to the foundation of marine stations, among which that at Naples was the first in point of time, as it always has been and is today, first in point of strength. But the development of educational institutions through the large continental areas and the limitations which their location imposed upon investigators connected with these institutions, together with the natural efforts of man to find a field for investigation which should afford him a better chance than already overcrowded territory, have led again to the investigation of fresh-water life. So it was that Fritsch, in Bohemia, entered upon lacustrine investigation as early as 1871, while about the same time Forel, in Switzerland, was carrying on those studies published between 1874 and 1879 in a series of papers on the 'Fauna of the

Swiss Lakes' culminating in the crowned memoir of the Academy of Sciences on the 'Abyssal Fauna of the Swiss Lakes,' that brought to the knowledge of the scientific world a hitherto unsuspected type of existence and offered a new and enticing field for investigation.

It was also in the same year, 1871, that Stimpson, one of the enthusiastic members of the old Chicago Academy of Sciences, conducted some dredging expeditions in the deep water of Lake Michigan, while about the same time Hoy, Milner and Forbes entered upon investigations at other points on these same lakes. The Chicago Academy and its collections, together with valuable manuscripts of Stimpson, were destroyed in the great fire, the U. S. Fish Commission, under whose auspices the work of Hoy and Milner was inaugurated, did not pursue further the investigations on the lakes, and for years Forbes was the only investigator who occupied himself in this country with the study of lacustrine life. To his work and influence we owe beyond a doubt in our own country the awakened interest in limnobiology, and under his direction also was established the first general fresh-water biological station on this continent, of which more in another connection.

The impulse toward the investigation of fresh-water life which was inaugurated by these men, gradually attracted to itself workers, slowly at first, but approximately a decade ago, with a sudden start the ranks of such were rapidly filled up. An enormous number of ponds and lakes, large and small, scattered over the surface of the continents, afforded an almost unlimited field for investigation, and many early studies were, to say the least, decidedly desultory. There were few workers who were content to confine themselves to a single locality, or to a well-defined problem. A scanty collection was made to serve as the basis of a faunal list supposed to charac-

terize the body of water in question, and the enumeration of species was regarded as the *ne plus ultra* of many investigators.

Like the spiritless systematic zoology, which, in the work of many minor investigators, followed upon the example set by the great Linnaeus, so lacustrine investigators in considerable number, were apparently satisfied to describe, as the results of brief sojourns, the fauna of a lake or lake regions, or, perhaps, even from a couple of vials of material collected by some rich patron in the course of a journey around the world, to discuss monographically the fresh-water fauna of the Fiji Islands, for instance. Under such circumstances there could be no biological study. The chief aim seemed to be to cover as much ground as possible in a short time. And what Lauterborn said five years ago is even truer today in the light of our more extended experience: "For the question as to the distribution of organisms, the methods so cherished even up to the present day of fishing in the greatest possible number of lakes (which recalls, in many respects, the chase after new summits on the part of our modern high climbers—*Hochtouristen*!), really have only limited claim to scientific value, since through them but a very incomplete picture of the faunal character of a water basin can be obtained."

The earlier investigators whose work has already been mentioned, Fritsch in Bohemia, and Forel in Switzerland, had been pursuing a single problem or investigating a limited locality for nearly twenty years, and they were among the first to emphasize the necessity of a modification of the prevalent tendency, and of a more formal character for lacustrine work, if valuable scientific results were to be expected from it. Forel was first to publish, in outline, a plan for the precise formal investigation of a body of water, in which emphasis was laid upon the necessity also of continuous and extended

investigation, before satisfactory conclusions could be hoped for. This programme has suffered some modification in detail at the hands of various students, but, in its general features, remains the aim and desire of workers everywhere. With the appreciation that such work must needs be formal, continuous and extended, came naturally the desire that stations of a permanent character should be established at various points for the realization of the idea. And the first of these that were founded were of a general character, concerned with the biological investigation of water as a problem of general scientific interest and importance.

But almost immediately other influences made themselves felt which have led to the extension of the general idea along particular lines of economic importance. Improved methods of fish catching and larger demands for fish food had brought various countries to the point where the drain on this kind of food supply was becoming very evident. The fish were being destroyed more rapidly than natural means could restore their numbers, and it was felt that something must be done by governmental agency to replenish the depleted waters. The first expedient of collecting and keeping under satisfactory conditions large numbers of fish eggs until they should be hatched, and the young fry distributed through the waters, was not so successful as had been hoped. The problem was too large to be attacked in such a superficial manner, and the further knowledge, which it became clear was absolutely necessary for proper handling of the question, must needs be sought through some means for the investigation of the conditions and determination of the steps necessary for the solution of the problem, and for carrying into effect the measures which might afford the desired relief. This led, first in Europe, to be sure, in connection with private enterprises for fish culture, to the establishment of bio-

logical experiment stations with the fish hatcheries, very much as chemical laboratories are now necessary adjuncts of various manufacturing interests, or agricultural experiment stations are connected with the higher development of agricultural possibilities. There is, however, a still further demand which has led to the formation of institutions of the general type which we are considering. The water supply of our cities has always been a serious problem, and one of increasing interest in connection with crowded conditions in the more thickly settled countries of the world, and the biological examination of the water, undertaken of necessity, has led to the organization of biological laboratories connected with the water systems of great cities, both on the continent, and in our own country.

Having thus discussed the causes which have led to the establishment of limnobiological stations, we may now consider, briefly, the types which they present, and the particular results which may be expected from a given sort. Of course all probable variations may be found, and it is difficult to make any classification which is complete or even just, and yet, for convenience, we may divide these enterprises into a few great groups, recognizing the fact that certain of them do not belong singly to any one class, but combine features of different types. But before outlining this classification, let me say that I do not regard the existence or non-existence of a building or structure devoted to the purpose of investigation as a necessary mark of a biological station. Some of the most valuable contributions to general and special questions in this field have come from investigators or groups of investigators who have had no abiding place, while, on the other hand, stations well equipped with buildings and apparatus have in some instances, so far as can be ascertained, contributed nothing even after several years' existence, to

the progress of scientific knowledge. Material equipment is valuable, and, in general, conduces to better results, and yet it is the results themselves which finally determine the character of any enterprise and the position which it should hold in the esteem of the world.

For the purposes of this discussion I propose dividing biological stations into, first, individual resorts, second, periodic resorts, and third, permanent stations. Individual resorts are such as are characterized by the work of one or more individual investigators, working for the most part independently, and solving their problems by virtue of their individual investigations. There are, of course, a large number of such places where some investigator has made sporadic or single efforts at the determination of the faunal character of a water basin, or has paid a number of occasional visits to such a locality for the same purpose. On the whole, these stations have accomplished comparatively little, although we find striking contradictions of the general statement.

They may also be of a more regular and definite character, and some of these personal investigations have been most valuable in extending our present knowledge of fresh water life. It may be noted here that the permanence or regularity which contributes to the success may be either in the location of the point at which the investigations are carried out, or in the definiteness of the purpose which is followed; thus Imhof's investigations on the pelagic fauna of the Swiss lakes were permanent in their value, and Zschokke's investigation of the biological character of elevated lakes carried on at numerous points in the Alpine chain, has resulted in fundamentally important contributions to the lacustrine fauna of high altitudes. Yet neither of these was at all confined to a single locality, though limited by a definite purpose.

Periodic resorts are those to which groups

of individuals are accustomed to go for a certain portion or season of the year, most commonly for a vacation period in accordance with which they are denominated summer or winter laboratories. The larger number of the investigators tends towards securing a more complete idea of the biological problem as a whole, so that the results obtained from such stations are of evident value. Yet, at the same time, it must be noted that they are distinctly inferior, even to many individual resorts, since during the larger portion of the year no investigations are carried on and the results obtained are necessarily partial and incomplete in their character, and hence unavailable for the decision of the broader and more fundamental biological questions.

Permanent stations are those at which operations are conducted throughout the entire year by a definite corps of observers. The continuity of their work renders their results valuable for the decision of general biological problems, and, at the same time, the permanent force which, in part, at least, is indispensable in such an institution, implies that the undivided attention of the observer is devoted to these problems; from this we may then expect justly that greater results will be obtained than in the case even of the best of individual resorts, since the investigators who are carrying on operations at these are, so far as I know, without exception, connected with educational or scientific institutions which demand at least a part of their time, and to that extent divide their interest and their energy.

It is furthermore clear from what has been previously said that such permanent stations are of two distinct classes. First, those which may be denominated general, even though their work is of the greatest value for special purposes, and second, those which are distinctively technical by virtue of their association with specific enterprises.

It is but natural that the different conti-

nents are very unequally represented with regard to the number of stations that have been established upon them, and with respect to the knowledge that has been gained in reference to their fresh-water fauna and flora. Thus, our knowledge of the Australian fresh-water fauna is confined, at present, to the report of collections made by travelers, and to the investigation of specimens raised by Sars from dry mud which had been sent to him. Of Africa we know that fifteen years ago an expedition brought word from Lake Tanganyika that while rowing across its waters they encountered swarms of jelly-fish, while many of the gastropod shells which were brought back with them showed, in an equally striking way, their marine character. These reports have been confirmed by an expedition that has just returned, and the strikingly marine complexion of the fauna of the lake can hardly be doubted. This appears all the more strange since collections made at Lake Nyassa, which lies decidedly nearer the sea, show nothing but what is specifically lacustrine. Such facts point, of course, to the importance of the African fresh-water stations of the future.

From various lakes of Asia, all the way from Ceylon to Siberia, numerous more or less extensive collections have been made by travelers, though there is hardly anything sufficiently extended to warrant the statement that a station has been located, even for a limited time, at any point, especially since the collections have not been investigated by men who had made them, but have been turned over as alcoholic material to European investigators for study. We do know, however, that Lake Baikal, which is situated almost in the center of the continent, harbors a rich molluscan and crustacean fauna that is characteristically marine in its form, and is further distinguished by possessing many sponges clearly of marine type, and at least one species of

seal (*Phoca*), a genus which is typically oceanic. A discussion on the meaning of these features lies far from the purpose of the present paper, but certainly such facts do point out most strikingly that the field of limnobiological investigation is not lacking in topics of extreme interest.

From South America reports concerning the fresh water fauna are perhaps most scanty of all. Frenzel, a German investigator who lived many years in Argentine Republic, has published some interesting studies made while there on the Protozoa; a few isolated notices of the lacustrine fauna from various regions complete the list.

From these statements it is apparent that the work done thus far outside of Europe and North America is exceedingly limited, and that for our judgment of the results in formal limnobiological investigations, we must look to the laboratories of these two continents. Among all European countries, Switzerland has furnished perhaps the greatest number of investigators and stations for limnobiology, together with the most extended and valuable results, although even yet there is not in that country, so far as I can ascertain, a building exclusively devoted to the purposes of this investigation. First and foremost among these investigators may be mentioned Forel, of the University of Lausanne,* to whom reference has already been made. His investigations have been carried on for more than thirty years on Lake Geneva; to him we are indebted for the first knowledge of the abyssal fauna of a fresh-water lake, for the first extended program and plan for the investigation of such a lake, and for the first effort towards the realization of such a plan, which finds its full expression in his '*Lac Léman*,' a monograph at present in the course of pub-

lication; the volumes which have appeared thus far treat of physical, chemical, and meteorological conditions on the lake, and are to be followed by others which will complete, with the flora and fauna, the entire limnologic investigation. The series will make a magnificent and permanent contribution to lacustrine investigation, and will serve as a model for the work of all times.

The work of Zschokke, professor at the University of Basel, has been directed as already mentioned towards the elucidation of the faunal aspect of elevated lakes. It has been carried on through many years at different points, including the lakes of the Jura to the westward, as well as those in various regions of the Alps proper, and his papers on the fauna of elevated lakes contain the only general statement of the problem as well as of the characteristic features of such localities that has yet appeared. Lake Constance has been the scene in recent years of the work of numerous investigators under the guidance of an association for the investigation of the lake, which has its headquarters at Lindau. The published accounts of these investigations have thus far been preliminary in character, and I am unable to learn whether there is a building devoted to the purposes of investigation, and whether the work is carried on throughout the entire year.

This lake was the scene of early investigations by Weismann in 1877, and the present work which was inaugurated about 1893 is under the direction of Hofer, of the University of Munich.

To Bohemia belongs the honor of having had the first definite building for lacustrine investigations in the form of the Bohemian Portable Laboratory which was constructed, in 1888, under the direction of Professor Fritsch, of the University of Prague. Reference has already been made to the early work of this investigator, who, in 1871,

* In a sense the laboratory of the University, which is located near the shore of the lake, is the building of the station, as in Wisconsin, mentioned below.

reported to the Academy of Sciences, in Prague, the results of the investigations of Black Sea, a small body of water in the Bohemian forest, with reference to the distribution of animals according to the depth of the water and their relation to the shore. These investigation which were extended to other lakes in the same year, are, I believe, the first at least to be recorded that were carried out in this way. It was, however, in 1888 before Fritsch succeeded in obtaining funds for a small portable zoological laboratory having some twelve square meters of floor surface. The station remained at its first location four years, and was replaced by a permanent structure when it was removed to another locality. This portable laboratory has been regularly visited at brief intervals of time by the director and his associates in the three localities at which it has been situated during the last ten years, and the contributions from this work constitute most valuable studies on the lacustrine biology of Bohemia.

In Finland there exists the laboratory of Esbo-Löfö, on one of the small islands which, though primarily a marine station, is so favorably located with reference to bodies of fresh water that it has devoted a considerable portion of its energy to the investigation of the fresh water fauna with valuable results. This laboratory has been maintained since 1895 under the direction of Professor Levander. Its contributions are published in the '*Acta Societatis pro Fauna et Flora Fennica*.' One of its workers, Dr. Stenroos, has for several years individually visited Lake Nurmijärvi, one of the small inland lakes with which Finland is so plentifully supplied, a body of water, which though it is about two and five-tenths kilometers in length by one in width, has a maximum depth of only one meter; he has given us a very complete faunistic and biologic study of its life.

Russia has recently established a station

on Glubokoe Ozero, or Deep Lake, in the Province of Moscow, under the patronage of the Imperial Russian Society for Fish Culture. The station is under the direction of Professor Zograf, of Moscow University, whose contributions to lacustrine investigation, have been made known especially in a paper on the lake regions of Russia from the biologic standpoint, which was read before the International Zoological Congress in 1893. I infer that the station is a permanent one, though probably of technical character, although precise information on these points has not been obtained. Hungary has maintained for some years a lacustrine station on Lake Balaton, one of the largest fresh-water bodies of Europe, having an area of over 266 square miles, though its maximum depth appears to be only 11 meters; it is surrounded by enormous marshy areas which give thus varied conditions for the development of life. Several parts of the report on these investigations have already been published. In France there exists a lacustrine laboratory near Clermont-Ferrand, which seems to have been organized in 1893; no reports or contributions from the station are recorded in the bibliographical records. At Paris, Drs. Richard and de Guerne have investigated collections from a large number of lakes not only in France and neighboring countries, but even from Algeria, Syria, the Azores and other points, and have published valuable contributions on the distribution of fresh-water crustacea, as well as systematic monographs of various groups.

In Germany all types of stations are represented, as might be expected, from the importance of scientific study in that nation. Individual investigators, not a few, have examined various lakes or lake regions, most prominent among them being undoubtedly Apstein, whose studies on Holstein lakes have extended over many years, and whose work on fresh-water plank-

ton is the first general statement of the problems and of the methods used by Hensen in the investigation of the marine life with such success, and by Apstein first applied to lacustrine investigation. Probably the best known fresh-water station in the world is that on Lake Ploen also in Holstein. This was the first permanent general fresh-water station to be established in the world. It owes its inception to the energy of its present director, Dr. Zacharias, whose plan was to establish for fresh water an institution similar to the Naples marine biological station. The station opened in 1891, and since that time it has been in continuous operation, and has afforded opportunities for investigation to a large number of scientific workers both German and foreign. It is the most pretentious of all fresh-water stations, having a building two stories in height, with numerous laboratory rooms and equipped with abundant apparatus for collecting and investigating. From it has been published yearly, since 1893, a volume of studies, and the director has also contributed largely to other journals on these problems. Two other stations in Germany owe their inception to the fishery problem, and have for their purpose more particularly the investigation of those limnologic questions which deal particularly with the life of the fishes. One of these is located at Müggelsee, near Berlin, and is conducted under the auspices of the German Fishery Association. The other, at Trachenberg, is under the auspices of the Silesian Fisheries' Association. Both have made important contributions to the biological questions concerned in fish culture.

All the North American stations which are known to me lie within the limits of the United States, and they represent all the various types of such institutions. A considerable number of workers have reported isolated investigations of lakes in all parts of the country from Maine to California.

Among the most important of these occasional observations are those made by Forbes on the fauna of elevated lakes in the Rocky Mountains. The observations which he has recorded were made in the course of a preliminary investigation of these lakes by the United States Fish Commission, and constitute the only information on record with reference to the lakes of the country west of the Missouri river. There are but two localities which may be listed, however, as individual resorts sufficiently regularly visited to entitle them to more particular mention in this place. Green Lake, in Wisconsin, has been carefully studied by Professor Marsh, of Ripon College, and his work has yielded valuable information with reference to the vertical distribution of the crustacea and with regard to the deep water fauna of the lake. Here he was able to confirm the observation of Stimpson, on Lake Michigan, that there are found in the deep waters of our large lakes crustacea of a purely marine type. At Lake Mendota, in Wisconsin, on the shores of which is located the State University, a careful investigation, extending over a very considerable number of years, has been carried on by Professor Birge of the University. The results which he has obtained with reference to the distribution, both vertical and seasonal, have been published by the Wisconsin Academy and are not only the most extensive, but beyond all comparison the most precise investigation which has been made on this problem.

Of course, in one sense, this station has no building, but the scientific laboratory of the University, standing within a stone's throw of the shore of the lake, affords opportunities which are not surpassed at any fresh-water station in the world.

Quite a number of periodic resorts of the type of summer laboratories are to be found in various parts of the country. Some of these are merely summer schools, such as

the biological laboratory of the Chautauqua College of Liberal Arts, on Lake Chautauqua. Others are both for teaching and for investigation, while only a small number are exclusively devoted to the investigation of limnologic problems from one standpoint or another. The University of Minnesota has maintained at Gull Lake, near the center of the State, a laboratory for summer work by members of the University, and for the prosecution of the natural history survey of the State under the direction of Professor Nachtrieb, of the University. The State University of Ohio has conducted, since 1896, a lake laboratory near Sandusky, on Lake Erie. It occupies one of the State fish hatcheries, and is supplied with the necessary apparatus by joint action of the University and State Fish Commission. Its purpose is to afford a convenient point of work for the members of the University, and also to aid in the prosecution of the State Biological Survey, which is being carried on by the Ohio Academy of Sciences. The immense stretches of shallow water, marshy regions, and protected areas, together with the varied character of shore and the open lake within easy reaching distance, serve to make Sandusky perhaps the most favorable place on Lake Erie for the study of the fresh-water fauna and flora. The station was closed a year ago, owing to the death of the Director, Professor Kellcott.

In 1895 the University of Indiana opened a Biological Station on the shore of Turkey Lake in the northern part of the State, under the direction of Professor Eigenmann of the University; a constantly increasing number of students has visited the station each summer. The majority of them have been teachers of the State engaged in the prosecution of work to equip them for their teaching, but others have also assisted in carrying out a general survey of the lake fauna and in the collection of material to

illustrate annual variation and associated problems. For comparison, collections have been made from adjacent lakes connected with other water basins. In the coming year the station is to be moved to the shores of Winona Lake, some 18 miles from the present location, where two buildings are to be constructed for its use by the Winona Assembly. The contributions from the laboratory have been published in the Proceedings of the Indiana Academy.

For a number of years the Michigan Fish Commission maintained a force of a few scientific investigators and assistants in conducting a biological examination of the inland lakes of the State, under the direction of Professor Reighard of the University of Michigan. In 1893 it was determined to transfer the seat of operations from inland waters to one of the Great Lakes, and by virtue, both of its convenient location and of its importance as a famous spawning ground of the lake fish, which had, however, almost ceased to visit it, Lake St. Clair was decided upon as the locality for the first year and the laboratory was located on a small bay at the northwest shore of the lake. The party consisted of half a dozen scientific workers whose attention was exclusively devoted each to his particular field, and the results of the survey were published in bulletins of the Michigan Fish Commission. In 1894 the station was moved to Charlevoix, a famous fishing region on the eastern shore of Lake Michigan, and, owing to the absence of Professor Reighard, in Europe, I was requested to take charge of the work. The scientific force and the methods of work were similar to those of the preceding year, but the location brought us in contact, not only with shallow waters, but also with the deeper regions of Lake Michigan, and the party made investigations and collections of a precise character in the deepest fresh water which has as yet been investigated by such methods. The

results of the summer's work were published in a bulletin of the Commission. Unfavorable financial conditions compelled the suspension of the work on the part of the Michigan Fish Commission, but American investigators owe much to the impetus which has been given to such work through their agency.

For many years the U. S. Fish Commission has been urged to establish on the Great Lakes a biological station similar to that which has long been maintained on the ocean, at Woods Hole, Mass. Finally, a year ago, a preliminary survey was undertaken with a view to deciding the advisability of such a movement and Professor Reighard was requested to assume the leadership of the enterprise. The U. S. Fish Hatchery at Put-in-Bay, a small island in the center of the west end of Lake Erie, was selected as the seat of operations and a party of scientific workers spent two months in studying the fauna and flora of the adjacent waters. It is to be hoped that this work may develop into a permanent experiment station on the Great Lakes.

Among permanent American stations of a technical character, the Experimental Filter Station of the Massachusetts Board of Health, located at Lawrence, is the best known as it is also, perhaps, the most famous of its kind in the world. It has been in continuous operation since 1887 and has conducted extended experiments on the biological examination of drinking waters; the methods worked out in connection with them are now standard for such purposes. Similar technical laboratories are in operation in Boston, Lynn, Worcester and other cities; but in most of them the biological examination of waters is only a secondary function. The Mount Prospect Laboratory, organized recently in connection with the Brooklyn Water Works, and placed under the direction of Mr. G. C. Whipple, whose contributions to limno-

biologic questions are well known, is more particularly devoted to the investigation of questions connected with the character of the water supply. Numerous samples taken from all the sources of the city's supply are subjected each week to physical, chemical, microscopical, and bacteriological examinations, and the quality of the water controlled thereby, since the reports made to the chief engineer serve to guide him in the choice of the sources from which the water is drawn. The results of such studies are also of great importance in general limnologic questions.

The University of Illinois was extremely fortunate in having associated with it, by statute, a state laboratory of natural history which has been engaged for many years in a natural history survey of the State. Under the direction of Professor Forbes, whose pioneer work on the lake fauna has already been noted, particular attention was paid to such questions as the food of fresh water fishes, and the distribution of various groups of fresh water organisms, so that both by preliminary work, and in the person of its director, the state laboratory was peculiarly fitted for the successful inauguration of an Illinois Biological Station which became possible under state grant in 1894. The laboratory secured a permanent superintendent in the person of Dr. Kofoed a year later, and work has been carried on continuously by a permanent force since that date. The laboratory was unique in its inception since the director, Dr. Forbes, conceived the idea of locating it on a river system rather than as all previous stations on a lake, and it was not only the first in the world, but is yet the only station which has peculiarly attacked the problems of such a system.

The Illinois river and its dependent waters were selected as the field of operations and Havana, Ill., as the center of work. The river here presents in its cut-offs, bayous, shallow, marshy tracts, sandy

areas with wooded margins and regions of spring fed waters, and with the enormous extent of land covered at high water, a variety of conditions which it must be confessed could not be surpassed, and hardly equalled elsewhere. The abundance and variety of the flora and fauna, both in the higher and lower forms of life, demonstrate the good judgment exercised in the choice of locality. A noteworthy feature in the equipment of this station, and so far as I know, one that is unique, is the floating laboratory which enables an easy transfer of operations to other points, where work can be carried on for comparison or contrast, with equipment and environment as satisfactory as that which exists in a permanent building, but with the flexibility and facility of movement which characterizes field studies. The work has been conducted uninterruptedly for more than three years, and the results include studies on the insects and their development, on the earthworms, on the Protozoa and rotifers, on various groups of crustaceans and general investigations on plankton methods and on the distribution of the plankton, while some work has also been done on the plant life of water. These studies have been published in the *Bulletin of the Illinois State Laboratory of Natural History*.

Let us consider, in conclusion, the function and future development of these institutions. It is perfectly clear that the work of the different types of fresh-water stations will vary somewhat with the class, and Zacharias has outlined carefully the differences in the work of the fixed and of the movable stations. But these are, after all, minor differences. All stations, whether fixed or movable, have really three objects: teaching, investigating, experimenting, objects which may be subserved directly or indirectly, or in both ways, by each one of them. It is unquestionably true that the tendency within recent years has been to

make the university trained scientist a laboratory man, unacquainted with work out of doors and among living things. This has reacted unfavorably upon his teaching powers, and thus indirectly upon the entire school system. Not that subjects in natural history are not better taught in our secondary schools than they were twenty years ago, when, in truth, they were hardly taught at all, but that the naturalist to-day is not trained as an outdoor observer and is little capable of handling himself and his work in a new environment. As Forbes says: "It is, in fact, the biological station, wisely and liberally managed, which is to restore to us what is best in the naturalist of the old school united to what is best in the laboratory student of the new." Thus, both through the influence of the investigators in the case of those stations which do not carry on directly any educational work, and through the teaching of those which do conduct summer instructional courses, new life will be instilled into the teaching of natural history throughout our country.

In the second place, the fresh-water station is a center for investigation with all its stimulating effects on the individual thus brought in contact with problems of Nature and efforts for their solution, and in the contributions to the advancement of knowledge which are the fruits of a careful work on the part of its attachés. All that has been said of the advantages of marine stations applies equally well to fresh-water laboratories, together with the added advantages that their accessibility brings these advantages to considerable regions which would otherwise be entirely without them by virtue of their distance from the sea. It is unnecessary that I should emphasize further this phase of the question, or dwell upon the greater simplicity of biological conditions in fresh-water over those which exist in the ocean. These factors have been forcibly presented by many writers.

Finally, the fresh-water station should be above all things an experimental one, and in this direction the most valuable results are to be looked for, both from the general scientific and from the technical standpoint. To the scientist, this needs no demonstration; but it is essential that the importance of such work, especially for fish culture, be more widely understood. The advance in agricultural methods in the United States is unquestionably due in large part to the development of a splendid series of agricultural experiment stations in which agricultural problems have been subjected to intensive experimentation. Contrasted with this, conditions in fish culture present almost the opposite extreme. Fish eggs have been hatched in enormous numbers, but what is known of their subsequent history or what has been done to insure the safe development to maturity of the fish? Present methods have reached their limit and the subject must be attacked from a different standpoint. Fish culture should receive by the liberality of state and nation the same favors that have been extended to agriculture, the use of permanent and well-equipped experiment stations where trained workers shall devote their time and energy to the solution of its problems. Thoroughness and continuity are essential, for these problems really deal with all conditions of existence in the water. Of what does the food of each fish consist, where is it found and in what amount, how may it be increased and improved; to what extent and how can the number of fish be multiplied, and how far is this profitable; what are the best kinds of fish and what new varieties can be produced? These are a few of the many questions to be solved.

The problems outlined are indeed vast, and yet we may be confident that their solution lies easily within the power of the human intellect, for they are all paralleled in the history of the agricultural develop-

ment of the race; and man, relying upon his success in the past, may go forward with supreme confidence to the attainment of their solution in this new field.

HENRY B. WARD.

ZOOLOGICAL LABORATORY,
THE UNIVERSITY OF NEBRASKA.

BRUNISSURE OF THE VINE AND OTHER PLANTS.

SINCE the publication, in 1892, of the papers by Viala and Sauvageau describing Brunissure of the Vine and the California Vine disease as due to *Plasmodiophora vitis* (Viala et Sauv.) and *P. californica* (Viala et Sauv.) much interest has been manifested in these supposed new parasites. F. Debray and A. Brive in *Revue de Viticulture*, 1895, claimed to have found the parasite in a large number of plants belonging to numerous families and genera. They made a new genus for the organism calling it *Pseudocommis vitis*. By far the best work, however, has been done by Viala and Sauvageau. A full discussion of their work with bibliography may be found in '*Les Maladies de la Vigne*, par Pierre Viala, Troisième édition 1893, pp. 400-413. Any one who has observed for himself the peculiar structures described would most likely decide at once that they must belong, or be at least closely related, to the genus *Plasmodiophora*. The peculiar vacuolate plasmodium-like structures may be best studied, following the directions of Viala (in *Maladies de la Vigne*), by slowly clearing the sections or tissues in dilute eau de javelle. The protoplasm of the host cell is said to be dissolved, while that of the plasmodies remains for a long time unattacked. The plasmodies may then be colored with iodine or other stains, bringing out their structure very sharply. I have recently repeated these experiments very carefully and find everything described by Viala and Sauvageau in *Vitis* and also as described by

Debray in other plants. In fact, the phenomena can be produced in all plants so far as I have examined, whether healthy or diseased, especially in cells containing chlorophyll. I obtained the plasmode structures readily in leaves and stems of *Vitis*, *Lilium harrisii*, *Tobacco*, *Tomato*, *Rose* and *Hyacinth* and in *Spirögyra* cells. If one watches the action of eau de javelle closely under the microscope a slight plasmolysis of the cells is first seen which may increase or afterwards disappear. The chloroplasts swell and become colorless and unite with each other, and usually with the rest of the protein, into an amorphous mass almost transparent. This mass after a time contracts into a single vacuolate plasmodium-like structure or into several such structures in each cell. These become highly refractive and remain without much change for several hours or disappear, according to the strength of the reagent. In this stage the plasmodes may be coagulated with alcohol or iodine and stained and permanently mounted in glycerine containing alcohol or iodine. If dilute glycerine or pure water is added before coagulation the plasmode structures swell, lose their high refraction and become amorphous. In coagulation these formations behave like any albuminoid substance. Their formation, however, is entirely different from the separation of active albumen in the cell by the addition of an aqueous solution of caffeine as described by Dr. Loew. This difference will be discussed in a fuller paper now in preparation. The action of the eau de javelle is most likely an oxidation in the presence of an alkali. Changes of the kind described are not produced by a mixture of sodium chloride 5% and sodium hydrate 1% or of either of these acting alone. A phenomenon quite similar, however, is produced in the Lily if the tissues are first soaked in peroxide of hydrogen till discolored and sections then mounted in sodium

chloride 5% and sodium hydrate 1%. The cell contents then quickly swell and become amorphous, and highly refractive-plasmode structures separate out. These gradually disappear if not coagulated with iodine or alcohol. In the latter case they behave as do the similar structures produced by the eau de javelle. If the theory is correct that these changes are produced by an oxidation of the chloroplasts and other cell contents in an alkaline medium it explains why such structures, or a reticulate form of them, usually appear in cells which slowly die and become brown around the punctures of aphids in the leaf of the Bermuda lily. Numerous tests made by the writer have shown that plants which react in this manner to aphid punctures contain much larger quantities of oxidizing enzyme than plants which do not so react. The presence of the substance injected into the wound by the aphid probably causes the neighboring cells to increase still more in oxidizing enzyme until the presence of the latter in excessive quantity destroys or oxidizes the chloroplasts. The cell slowly dies, and the rest of the cell contents may then be attacked. A brownish shrunken amorphous mass is left. On the addition of dilute potassium hydrate or sodium hydrate to sections from such spots the oxidized protoplasm in the cells which have turned brown swells up and becomes a reticulated or vacuolate mass, such as is often obtained with the eau de javelle or the peroxide of hydrogen and sodium hydrate. It is quite likely, therefore, that plasmode structures would be formed by an alkali in any cells that had previously become oxidized either from the presence of oxidizing enzyme in themselves or from any other cause. These observations indicate quite decidedly that the supposed *Plasmodiophora vitis* or *Pseudocommis vitis* are nothing but microchemical reactions, brought on by oxidations and the influence of an alkali upon the en-

tire protein contents of cells, especially upon chloroplasts.

A complete account of the work with illustrations will be published soon.

ALBERT F. WOODS.

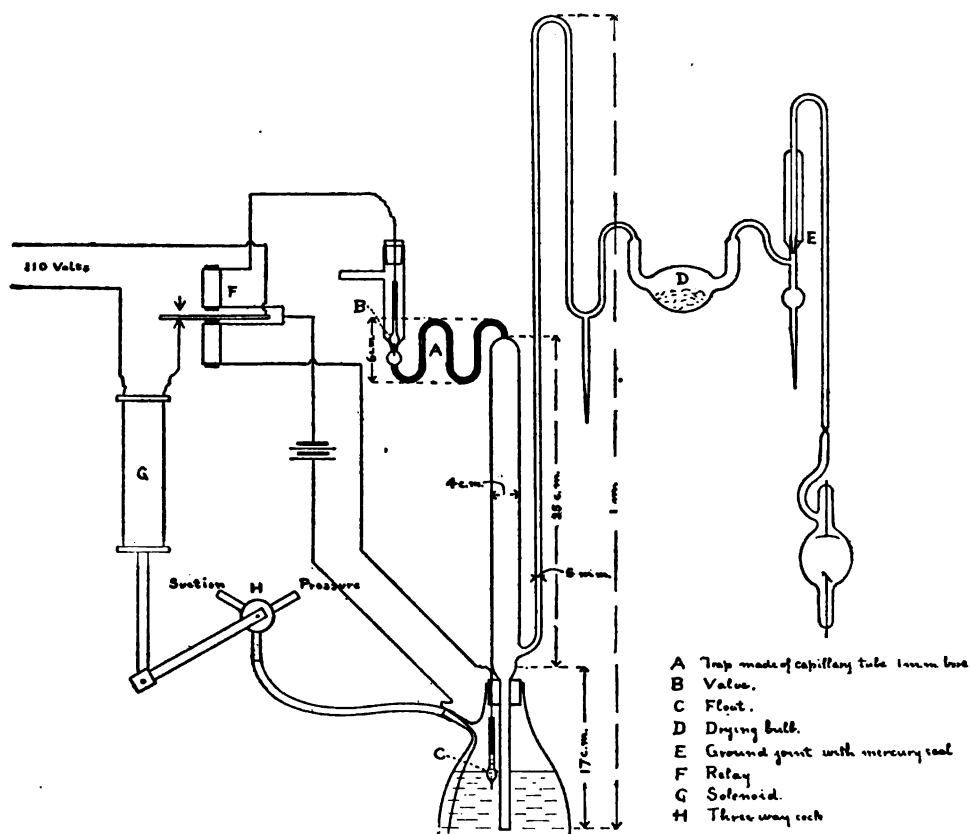
DIVISION OF VEGETABLE PHYSIOLOGY
AND PATHOLOGY, U. S. DEPT. AGRICULTURE.

AN AUTOMATIC MERCURY PUMP.

ALTHOUGH there is nothing especially new in regard to the pump proper, the method of electrical control may be sufficiently novel to warrant a brief description.

flask filled with mercury. A tight joint is made between the flask and pump by a rubber stopper. This stopper also serves as a flexible support for the body of the pump. The exhaust tube is sealed into the pump just above the point at which the pump passes into the flask. The arrangement is best shown by the figure.

The tube to be exhausted is attached to the pump, through a drying bulb filled with anhydrous phosphoric acid, by a simple ground joint with a mercury seal. The valve at the top of the pump is ground to



The pump proper is a modification of a common form of Geissler pump. It consists of a long glass tube, about $1\frac{1}{2}$ inches in diameter, which has a mercury trap and a small glass valve at the top. The bottom of the tube is drawn down and dips into a

fit its seat and so weighted by filling with mercury that it closes, leaving sufficient mercury above it to form a tight joint. Dimensions which give very satisfactory results are shown on the figure. Suction is applied permanently to the top of the pump

above the valve. The mercury in the pump is raised or lowered by applying atmospheric pressure or suction to the flask. The suction necessary to operate the pump is obtained by a small water-jet pump giving a vacuum of about 28 inches. A pump with the valve alone will work fairly well, except that occasionally, when the quantity of air taken out at each stroke becomes small, a little bubble will cling to the valve and refuse to pass out of the pump. To avoid this, a trap is added below the valve to prevent any air which might fail to pass the valve from returning to the pump.

The only requisite to make the pump automatic is to have some means of controlling a three-way cock which will apply either pressure or suction to the flask. This control is obtained electrically by making and breaking a circuit in the valve at the top, and in a float in the flask at the bottom. A permanent electrical connection is made with the mercury in the flask at the bottom. A platinum wire sealed into the tip of the valve serves to connect electrically the mercury in the valve with that in the pump. An iron wire dips into the stem of the valve and serves as a final contact. The mercury rising in the pump first makes contact with the inside of the valve through the platinum wire. As it continues to rise the valve opens floats and completes the circuit by the iron wire. It will be seen that the final contact is made in the valve, and any sparking that may occur can in no way foul the mercury in the pump. When the mercury in the pump reaches its lowest level a float in the flask similar to the valve at the top closes another circuit. These two circuits control a relay which in turn controls a solenoid connected to the three-way cock. The solenoid is wound for 110 volts and takes only a small current. One or two Leclanché cells are sufficient for the relay. The electrical connections are shown in the figure.

A pump of this form has been in use at the Massachusetts Institute of Technology for over two years, and has proved very satisfactory. It works quickly, and will give high Crookes vacuum without trouble.

In starting the pump, the pump and whatever may be attached to it are first exhausted by the water pump to about two or three inches' pressure. For the first few strokes, which are made by hand, the mercury is allowed to rise only part way in the pump. After this the necessary electrical circuits may be closed and the pump will take care of itself. In this way the dangerous hammering of the mercury occurring when the quantity of air taken out at each stroke is large can be avoided.

I am indebted to Mr. C. L. Norton for valuable assistance in developing this pump.

RALPH R. LAWRENCE.

ROGERS LABORATORY OF PHYSICS,
MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

SCIENTIFIC BOOKS.

The Wonderful Century. By ALFRED RUSSELL WALLACE.

As the human mind is more wonderful than anything else that we find in nature, so the greatest and most significant difference between the 'Wonderful Century' and all that had gone before is an intellectual difference.

It is not invention and discovery and the extension of man's dominion over nature, but the establishment of the conviction that we know no limit to this movement, that is the chief distinction of our century.

Among those who have, in our day, guided the thoughts of men to this conviction, future historians will give the highest place to Lyell, and Wallace and Darwin; for no one in our century has done more than they to assure us that the scientific method is adequate; even if successive generations of 'philosophers' still continue to teach that the very top and perfection of human wisdom is the assertion that we know, and can know, nothing.

With modesty which some hold to do him less than justice, Wallace believed that Darwin so much surpassed him in strength and wisdom and in acquaintance with nature that it became his duty to devote his life to the assistance of Darwin in his efforts to extend the province of human knowledge into regions that had been declared closed. The intellectual revolution has come about, nor will the thoughtful permit Wallace's part in bringing it about to be forgotten; nor can we forget the generous devotion which chose the advancement of truth before the natural desire for recognition and distinction. No one can suspect that such a man as Wallace has proved himself will ignore or depreciate the share of anyone in this great work, and few chapters of his book on 'The Wonderful Century' are more interesting than the one in which he touches, very gently and tenderly, upon the part which the 'philosophers' have had in the progress of natural science.

It is one thing to show that there is no logical basis for belief that species are immutable, but it is quite a different matter to show what modifies species. It was by finding out, and not by exposing the weakness in the logic of those who asserted that we never can find out, that Wallace and Darwin passed the bounds where they had been told that natural knowledge ends.

Lamarck, and Chambers, and Herbert Spencer, and many others, even Wallace himself, had shown that there is no reason to doubt that species are mutable; but all had failed to show how the changes take place; and many eminent men of science, as well as the general public, refused to consider beliefs which were as yet beliefs and nothing more.

What educated public opinion was before the publication of the 'Origin' is shown, says Wallace, by the fact that neither Lamarck nor Herbert Spencer nor the author of the 'Vestiges' had been able to make any impression upon it. The very idea of progressive development of species from other species was held to be a 'heresy' by such great and liberal-minded men as Sir John Herschel and Sir Charles Lyell; the latter writer declaring, in the earlier editions of his great work, that the facts of geology are 'fatal to the theory of progressive

development.' The whole literary and scientific worlds were violently opposed to all such theories, and altogether disbelieved in the possibility of establishing them. It had been so long the custom to treat species as special creations, and the mode of their creation as the 'mystery of mysteries,' that it had come to be considered not only presumptuous, but almost impious, for any individual to profess to have lifted the veil from what was held to be the greatest and most mysterious of Nature's secrets.

Wallace tells us, 'The Wonderful Century,' p. 139, that after he had studied what had been written, and even after he had himself written about the mutability of species: "I had no conception of *how* or *why* each new form had come into existence with all its beautiful adaptations to its special mode of life; and though the subject was continually being pondered over, no light came to me till three years later (February, 1858), under somewhat peculiar circumstances. I was then living at Ternate, in the Moluccas, and was suffering from a rather severe attack of intermittent fever, which prostrated me for several hours every day during the cold and succeeding hot fits. During one of these fits, while again considering the problem of the origin of species, something led me to think of Malthus' Essay on Population (which I had read about ten years before), and the 'positive checks'—war, disease, famine, accidents, etc.—which he adduced as keeping all savage nations nearly stationary. It then occurred to me that these checks must also act upon animals, and keep down their numbers; and as they increase so much faster than man does, while their numbers are always nearly or quite stationary, it was clear that these checks in their case must be far more powerful, since a number equal to the whole increase must be cut off by them each year. While vaguely thinking how this would affect any species, there suddenly flashed upon me the idea of *the survival of the fittest*—that the individuals removed by these checks must be, on the whole, *inferior* to those that survived. Then, considering the *variations* continually occurring in every fresh generation of animals or plants, and the changes of climate, of food, of enemies always in progress, the whole method

of specific modification became clear to me, and in the two hours of my fit I had thought out the main points of the theory."

If this had been only a fortunate guess it would have little interest, for no one cares to ask whether Empedocles, or Wells, or Mathew, or Darwin, or Herbert Spencer, or Wallace first had this happy thought. It was because Wallace had spent years of hard work in gathering facts and in pondering them that he was able to see that this sudden product of his 'fit' was worthy of further examination, and because he devoted the rest of his life to its application to new discoveries that he is held to be the joint discoverer of the law of Natural Selection.

The origin of species by means of natural selection is now universally accepted as a demonstrated principle. "This," says Wallace, "is, of course, partly due to the colossal work of Herbert Spencer; but for one reader of his works there are probably ten of Darwin's, and the establishment of the theory of the *Origin of Species by Means of Natural Selection* is wholly Darwin's work. That book, together with those which succeeded it, has so firmly established the doctrine of progressive development of species by the ordinary processes of multiplication and variation that there is now, I believe, scarcely a single living naturalist who doubts it. Probably so complete a change of educated opinion, on a question of such vast difficulty and complexity, was never before effected in so short a time. It not only places the name of Darwin on a level with that of Newton, but his work will always be considered as one of the greatest, if not the very greatest, of the scientific achievements of the nineteenth century, rich as that century has been in great discoveries in every department of physical science."

To this we must add that, so long as the 'Origin of Species' holds its place on the shelves of students, close beside it we shall find the 'Malay Archipelago;' for the writer of this review has no doubt that Wallace will be one of those to whom future generations will say: "Friend, Go up higher."

W. K. BROOKS.

JOHNS HOPKINS UNIVERSITY,
BALTIMORE.

The Principles of Bacteriology. By DR. FERDINAND HUEPPE. Translated by PROFESSOR E. O. JORDAN. Chicago, The Open Court Publishing Co. Pp. 455.

American bacteriologists certainly owe a debt of gratitude to Professor Jordan for putting into clear English this valuable contribution to the science of bacteriology of Professor Hueppe, of Prague. Hueppe's contribution to bacteriology in this volume is no ordinary one. The book is not simply a review of facts, but is decidedly original. From the first to the last the author and his opinions are decidedly in evidence. Whether or not one is inclined to agree with him in all his conclusions, no one will question the force of the arguments with which he upholds his opinions.

After giving some general information in regard to bacteria (in which the author accepts the conclusion that the tuberculous bacillus is not a bacterium at all) he deals in successive chapters with the vital phenomena of bacteria, pathogenic bacteria, the cause of infectious diseases, cure by combating the cause, immunity, prevention and history. The chapter upon vital phenomena of bacteria is especially valuable, since it treats, in a comprehensive manner, of the somewhat obscure subject of the chemistry of bacterial poisons and bacterial nutrients.

But the most suggestive part of the work begins with the chapter upon the cause of infectious disease. Here he sets himself in opposition to the school of Koch by denying that bacteria can in any proper sense be regarded as the cause of disease, and especially repudiating the idea that definite species of bacteria are the 'specific' cause of 'specific' diseases. No one can question Hueppe's thorough acquaintance with the facts of modern bacteriology, and it seems a little strange that he can hold a position so generally at variance with that of most bacteriologists. But we soon learn that his position is not so different from that of Koch as at first appears, and perhaps not so different as Hueppe tries to make it appear. Hueppe is, of course, fully aware that diseases are produced in animals by inoculating them with certain bacteria cultures. His criticism is simply against the claim that they are the *cause* of the disease and

that definite species cause definite diseases. That they *provoke* diseases he recognizes; that they *cause* them he denies. His own position is essentially as follows: Disease and health alike are attributes of the activity of living cells.

Health is the result of the normal activity and disease of the abnormal activity of these cells, and it is hardly more correct to say that disease is caused by bacteria than to say that health is caused by their absence. Disease is a process, not an entity, and is really caused by some condition of the living cells which makes them liable to act abnormally when stimulated. No disease can appear in the body except such as are predisposed in the living cells. The bacteria serve as a stimulus just as the spark serves as a stimulus for gunpowder. The spark is not the cause of the explosion, though it may excite it. There is a certain amount of resistance to be overcome before the cells will start to act abnormally, and the bacteria simply overcome this resistance. We are learning to appreciate more and more fully that one animal may be predisposed to a disease while another is more resistant, a fact in itself which shows that we are speaking very loosely when we say that the bacteria cause the disease. According to Hueppe disease is the result of a number of factors of unequal weight. External conditions constitute one factor, the condition of the body cells a second, and the presence of certain bacteria a third. When together they produce disease. Break the chain as one link and there is no disease. The school of Koch has paid attention to one of these links, the school of Virchow to the second, while Petinkoffer is trying to study the third, *i. e.*, external conditions. Hueppe insists that neither one causes the disease, but all three together. Disease is a vital activity, and while bacteria are needed to stimulate it they don't properly cause it.

This conception, of course, largely determines the position which Hueppe takes in the other topics considered. The question of combating the disease by combating the bacteria is only one side of the matter. Prevention involves something more than simply looking after the bacteria. Hygienic measures are mis-

directed if they look simply toward the destruction of bacteria. The disinfecting mania which developed a few years ago he regards as exaggerated and largely needless. Hygienic measures in the past have been very useful and produced a decided improvement in public health, but this has not been because they have destroyed the 'specific' bacteria. Rarely do we succeed in this object. Sanitariums for tuberculosis pay little attention to the matter of germs. The success has resulted from the fact that hygienic measures and cleanliness, together with fresh air and sunlight, have improved the *general health*, given the cells greater vitality and made the individual less disposed to acquire the disease. They are successful because they have been directed to the second link in the chain rather than the third.

It is a question whether his position is quite so much at variance with generally accepted belief as Hueppe is inclined to think. In denying that distinct bacteria are 'specific' he fails satisfactorily to reconcile this position with the fact that definite species do provoke definite diseases. He fails to make it clear just how the bacteria act to produce distinct diseases if they are not specific. It is a somewhat curious position to assume that the silk worms have always had a special predisposition to pebrine, but that this disposition only appeared when the pebrine organism made its appearance, especially as it appears that all individuals yield to the attacks of this germ. But apparently Hueppe would assume that the animals have had this predisposition to a disease which never had a chance to develop until the proper organism produced the stimulus. Hueppe has perhaps just as truly overdrawn the case from his point of view as Koch did from his own standpoint. But certainly all bacteriologists may read with profit this somewhat new setting-forth of the problem of bacterial diseases, and Hueppe is certainly to be thanked for bringing forward so forcibly the part which the vital activity of the organism plays in the matter of disease. He has certainly done a valuable service in pointing out that the problem of the physician and bacteriologist is to be directed toward the man and not the bacterium.

H. W. C.

The Elements of Graphic Statics. By L. M. HOSKINS, Professor of Applied Mechanics in the Leland Stanford Jr. University. New York, The Macmillan Company. 1899. Revised Edition. Pp. viii + 199, and eight plates.

The character of works under the head of Graphical Statics varies between that extreme of which Cremona's treatise may be regarded as typical, in which the name can be regarded as scarcely more than a peg on which to hang a large amount of theoretical projective-geometry matter, and the opposite extreme, where we may place the work before us, characterized, as it is, by intense practicality and general avoidance of everything of merely theoretic or historic interest. The favorable impression made upon one by the mechanical excellence of Professor Hoskins' book is further confirmed by a careful examination of the text.

Avoiding the error of Culmann in presupposing too much information on the part of his students as to projective relations and graphic methods, the author lays his own foundation on which to build, treating the subject more, however, as a branch of mechanics than of geometry. To this his Part I. is devoted, and it would seem impossible to set forth the fundamentals more clearly and concisely than in the fifty pages devoted thereto.

Familiarity with analytics and the calculus is assumed for the remainder of the work. Bow's convenient system of notation is employed throughout.

Excluding entirely from the book any consideration of structures whose discussion involves the theory of elasticity, the hundred pages constituting Part II. are devoted to the usual problems of beams and of bridge and roof trusses. We have not at hand a copy of the original edition for comparison with the revision, but as Professor Hoskins' preface indicates that the principal changes are in this section we state them in this connection in his own words: "In the present revised edition no change has been made in general plan, and few changes in the treatment adopted, except in the portions relating to beams and trusses carrying moving loads. These portions have been wholly re-written. It is believed that a substantial improvement has been made upon

the methods hitherto used, particularly in the criterion for determining the position of a given load-series which causes maximum stress in any member of a truss. The improvement consists in generalization, which is believed to be gained without sacrifice of simplicity. The graphical method of applying the criterion in the case of trusses with parallel chords has been fully treated by Professor H. T. Eddy. The method here given applies without the restriction to parallel chords. The algebraic statement of the same criterion, as given in Art. 152, is also believed to be a useful generalization of the methods hitherto used. Whether the algebraic or the graphical treatment is preferred, a method is useful in proportion to its generality, provided this does not involve a loss of simplicity. There is a decided advantage in the use of a single general equation applicable to any member of any truss, instead of several particular equations, each applicable to a special member or to a special form of truss." That this generalization will be cordially welcomed and availed of by the profession may safely be predicted.

Part III. gives graphic methods of determining centers of gravity and the moments of inertia of plane areas, with a discussion of inertia-curves, carried as far as the practical engineer will ordinarily need. Eight clear, double-page plates complete the work, and one's only regret in viewing them is that they cannot face the text describing them, to the saving of the student's time and temper.

We notice that the author uses a term, 'complanar' (whether he suggests it or not is not evident), which we trust will not supplant the generally accepted 'con-plane,' which is consistent with the other equally self-explanatory terms con-focal, con-axial, etc., and needs no modification.

The book is a thoroughly good one preëminently for the class-room, and a course in it should be a pleasure alike to pupil and instructor.

FRED'K N. WILLSON.

PRINCETON UNIVERSITY.

GENERAL.

PROFESSOR MARTIN'S books on *The Human Body* are in many ways models in the presenta-

tion of a difficult subject. We are glad to receive 'The Briefer Course' (Holt), revised by Professor G. W. Fitz, of Harvard University, and to commend it cordially. The book has been corrected throughout and a chapter added on growth and nutrition. The three appendices, which occupy nearly one fourth of the book, are all open to criticism. They are on 'Emergencies,' 'Alcohol and Tobacco' and 'Demonstrations and Experiments.' 'Emergencies' make up part of the examination in physiology which may be taken for entrance to Harvard College, but it is not evident that a school boy will profit intellectually or practically by being told how to treat apoplexy. The demonstrations and experiments, also part of the Harvard examination, may in their present form be useful for the teacher, but scarcely for the student. The reviser states that the appendix on narcotics is retained against his judgment. The injurious effects of narcotics must by foolish laws be taught in most public school courses on physiology; but it would be possible to prepare a statement that would be scientifically correct, even though its teaching might be ethically obnoxious. The statements in this book are not exactly incorrect, but they would produce false impressions on young students. The results of excess are pictured, and the boy is left to infer that the final state of his father, who drinks a glass of wine for dinner, will be delirium tremens. But the boy will be more likely to conclude that physiology is not an 'exact' science.

MINERVA, 'A Yearbook of the Learned World,' is indispensable to the editor and useful to every one who wishes to keep informed on the progress of education and science. As is well known, the book contains accounts of universities, libraries, museums, learned societies, etc., throughout the world. The names of over 25,000 officers of these institutions are given, and with an accuracy that is truly remarkable. The eighth volume, 1899, which reaches us from Messrs. Lemcke and Buechner (12 Broadway, New York City), is thoroughly revised from official sources, and is enlarged and improved in several respects, including the addition of a number of Canadian institutions. Programs of the various international scientific

congresses are promised for next year. The importance of the great universities of the world cannot be judged from the number of students, as the data are not comparable, but in this respect the order of the first ten is given as follows: Paris, 12,047; Berlin, 10,306; Madrid, 6,143; Vienna, 5,710; Naples, 5,103; Moscow, 4,461; Budapesth, 4,407; Munich, 3,997; Harvard, 3,674; St. Petersburg, 3,615. As a matter of fact, Harvard, with over 5,000 students all told, is probably now the fourth in size of the universities of the world, being surpassed only by Paris, Berlin and Vienna. There are thirty universities having over 2,000 students, and, of these, nine are in the United States, four in Russia and in Great Britain, three in France, in Germany and in Austria-Hungary, two in Italy and one in Spain and in Greece.

ANOTHER useful work of reference is *Who's Who?* edited by Mr. Douglas Sladen and published by Black in London and by Macmillan in New York. It contains brief bibliographies of people talked about in Great Britain, including all the leading men of science and a complete list of the members of the Royal Society. Americans are also noticed, but only in small numbers. Presidents Gilman and Harper are included, but not President Eliot. The late Professor Marsh is the only American man of science whose name we have noted.

BOOKS RECEIVED.

Report of the Seventh Meeting of the Australasian Association for the Advancement of Science, held at Sydney. Edited by A. LIVERSIDGE. Sydney, Published by the Association. Pp. lii+1161. 10s. 6d.

Éléments de Botanique. PH. VAN TIEGHEM. Paris, Masson et Cie. 1898. 3d edition, revised and enlarged. Vol. I., pp. xvi+559. Vol. II., pp. xv+612.

The Fairy Land of Science. ARABELLA B. BUCKLEY. New York, D. Appleton & Co. 1899. Pp. x+252.

How to Know the Ferns. FRANCIS THEODORA PARSONS. New York, Charles Scribner's Sons. 1899. Pp. xiv+210. \$1.50.

Papers and Addresses. N. Y. State Veterinary College, 1896-1898. Ithaca, N. Y. 1898.

Die Continuität der Atomverkettung. GEORG HÖRMANN. Jena, Gustav Fischer. 1899. Pp. 118. Mark 3.

Text-Book of Physics—Sound. J. H. POYNTING and J. J. THOMSON. London, Charles Griffings & Company; Philadelphia, J. B. Lippincott & Co. Pp. x+163.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *American Journal of Science* contains the following articles:

Glacial Lakes Newberry, Warren and Dana, in Central New York, H. L. FAIRCHILD.

Rapid Method for the Determination of the Amount of Soluble Mineral Matter in a Soil, T. H. MEANS.

New Type of Telescope Objective especially adapted for Spectroscopic Use, C. S. HASTINGS.

Phenocrysts of Intrusive Igneous Rocks, L. V. PIERSON.

Occurrence, Origin and Chemical Composition of Chromite, J. H. PRATT.

Influence of Hydrochloric Acid in Titrations by Sodium Thiosulphate, J. T. NORTON, Jr.

Rock-forming Biotites and Amphiboles, H. W. TURNER.

One Little Known and one Hitherto Unknown Species of *Saurocephalus*, O. P. HAY.

Some American Fossil Cycads, G. R. WIELAND.

THE *American Geologist* for April opens with an extended article by Professor William M. Davis on the peneplain, being a reply to an article by Professor Tarr in a previous issue of the journal. Professor Davis writes from Cannes, France. Following are articles: By Professor George E. Ladd, on the Cretaceous Clays of Middle Georgia; by Professor H. N. Winchell, on the optical characters of Jacksonite, and by Professor C. H. Hitchcock, giving an account of his observations in Australasia.

THE *Journal of the Boston Society of Medical Sciences* contains a paper by Dr. Franklin G. White on 'Blood Cultures in Septicemia, Pneumonia, Meningitis and Chronic Disease,' in which, among the conclusions reached, is that the detection of specific bacteria in the blood in cases of sepsis and pneumonia gives an unfavorable prognosis. A brief but interesting article by E. H. Bradford treats of the 'Movement of the Front of the Foot in Walking;' and Dr. John Dane follows with a 'Report of Some Studies upon the Arch of the Foot in Infancy,' showing that this arch is present in infants but is masked by a sustaining pad of fat.

THE frontispiece of the *Osprey* for February is a plate of the Hairy Woodpecker by Fuertes; the first article, 'Notes from North Dakota,' by E. S. Rolfe treats of egg collecting in the vicinity of Devil's Lake. Mr. Geo. F. Breninger has an article on 'Gambel's Quail;' and Rev. W. F. Henninger discusses 'The Scourge of Egg Collecting' in a manner perhaps a little over-zealous, but with an array of facts that merit serious consideration. The feature of the number is Dr. Gill's long letter headed 'A Great Work Proposed,' wherein he lays before the readers at some length a number of suggestions for a new history of North American birds. The publication of the *Osprey* for March brings this magazine down to date; Julia S. Robins contributes an article on Wilson entitled 'Behind the Wedding Veil,' and Witmer Stone follows with a too short paper on 'An Old Case of Skins and its Associations,' being notes on one of the earliest ornithological collections in the United States. In 'Snap Shots with Pen and Camera,' E. S. Rolfe gives us half a dozen views of birds and nests, with accompanying text. 'The Gourdheads in the Cypress Swamp of Missouri,' by Otto Widmann, tells of the habits of the Wood Ibis, gourdhead being a local name for this bird. W. B. Davis has some suggestive notes on 'Odd Actions of Birds Unexplained,' and the customary notes, editorials and reviews complete this unusually good number.

SOCIETIES AND ACADEMIES.

CHEMICAL SOCIETY OF WASHINGTON.

THE regular meeting was held on February 9, 1899.

The first paper of the evening was read by Mr. F. D. Simons, and was entitled 'The Detection of Caramel Coloring Matter in Spirits and Vinegar,' by C. A. Crampton and F. D. Simons.

The paper states that the two principal tests given in the books for the detection of caramel coloring matter are, first, the reduction of Fehling's solution, and second, the precipitation of the caramel by means of paraldehyde. Neither of these tests has given satisfactory results in the hands of the authors.

It was found that fuller's earth had a selective affinity for caramel coloring matter in spirits, while the natural color derived from wood was but slightly affected. The test is made by beating up twenty-five grams of the earth with fifty cc. of the sample to be tested, allowing it to stand for thirty minutes at room temperature, and filtering. The color before and after treatment is observed by means of Levibond's tintometer or other form of good colorimeter, and the amount of color removed ascertained in this way.

The test was applied to all the samples of spirits available in the laboratory of internal revenue, positive results being obtained in all cases. A series of 40 samples known to be naturally colored gave an average of 14.6 per cent. of color removed, while 18 samples of spirit known to be colored with caramel averaged 44.7 per cent. of color removed.

The test was also applied to a few samples of vinegar, with good results.

The second paper of the evening was read by Dr. David T. Day, and was entitled 'Characteristics of Iridosmium in the United States.'

A demand has lately arisen for this material as a source of osmium, with which it is proposed to impregnate the filaments of incandescent lights, with most beneficial results as to the amount of light supplied by a given current and the increased life of the lamp. The problem of supplying a large amount of osmiridium is a most fascinating one and has led to much study in the localities of the West where platinum metals have been found. The results show that platinum is much more generally distributed through the western placer mines than was supposed and that there are localities containing so-called crude platinum, in which osmiridium is found. A sample sent from the Oregon beach contained as high as 99 per cent. of osmiridium. The Hay Fork District, in Trinity county, California; Junction City, and more especially the whole Pacific Coast beach, is a most interesting field of search because the platinum is mixed with much osmiridium. It can be said in general that nearly all the crude platinum sand contains osmiridium in greater or less quantity, according to the analyses of a great number of sands made by Dr. Waldron Shapleigh, for the Welsbach

Light Company. An interesting exception is the Granite Creek District, of British Columbia. A curious form of osmiridium was noted at the Chapman Mine, near Junction City, California, where nuggets $\frac{1}{2}$ inch in diameter, when treated with warm dilute nitro-hydrochloric acid, yield platinum in solution and flakes of osmiridium. The separation of the platinum from the osmiridium is readily accomplished by means of nitro-hydrochloric acid, and the separation of osmic acid from the residue is quite simple by the ordinary process of passing chlorine over the osmiridium mixed with salt. The purification of the osmic acid is now effected by redistillation, but it is probable that these methods will be much improved within the next few months. It is probable that 2,000 ozs. of the material will be obtained during 1899.

The last paper of the evening was read by Dr. Day, and was entitled 'Uses of Fuller's Earth as a Filtering Medium.'

In 1892 an effort was made by the Owl Cigar Manufacturing Company at Quincy, Florida, to manufacture brick from a peculiar cream-colored clay found on their property. Instead of baking hard, it exfoliated in a peculiar manner and caused some comment from an Alsatian cigar-maker in the employ of the company, who noticed this clay and called attention to its close resemblance to German fuller's earth. This led to an inquiry as to its value as fuller's earth, at a time when the lubricating oil companies were looking for domestic fuller's earth to replace animal charcoal as a means of lightening the color of lubricating oils by filtration. The earth proved very suitable, and its use extended in this direction as well as to some extent in the bleaching of vegetable oils. But for the latter purpose the imported fuller's earth is still approved. The number of samples of clays which have been called fuller's earth and sent to the consumers for examination since that date is almost beyond belief. It has been shown that fuller's earth is quite widely scattered in the northwestern counties of Florida and the adjacent counties of Georgia. In the latter region the fact that it grades into chalcodony makes it more probable that the fuller's earth is a chemical precipitate, and this is further indicated by the replacement of calcium car-

bonate by the silica in many shells found associated with the fuller's earth.

The Florida and English fuller's earth differ greatly in appearance and to some extent in chemical composition. English fuller's earth has found its analogue in the material discovered at Fairburn, near Rapid City, South Dakota, and Valentine, Nebraska. It is altogether probable that further developments will make the material from these places an important article for use in bleaching cotton-seed oil. There is an interesting difference in the methods of testing the Florida fuller's earth as compared with the English. It is the constant practice of the lubricating oil companies simply to fill large, slightly conical cylinders with the fuller's earth, ground to about 40 mesh, through which the oil is filtered at about the temperature equal to that of boiling water. At first the filtrate is perfectly colorless and, strange to say, lighter in specific gravity and more fluid than the unfiltered oil, a fact which will probably be made use of in chemical separations of the future. Dr. Day is now using this in investigating oils. Fuller's earth is used for bleaching refined, golden cotton-seed oil to a light straw color. When the resultant is to be used for white products, such as lard substitutes, the fuller's earth is ground to a fine powder and stirred into the oil slightly above the temperature of boiling water. After a thorough mixing by agitation for a few moments the bleached oil is simply filtered through bag presses. Perhaps the most interesting feature of this use of fuller's earth is the very slight difference in the two varieties of fuller's earth in regard to their bleaching capacity, which leads to their acceptance or rejection. Little regard is paid to chemical analysis, but the tests made by filtration, on a small scale, are most severe."

WILLIAM H. KRUG.

GEOLOGICAL CONFERENCE AND STUDENTS' CLUB
OF HARVARD UNIVERSITY.

Students' Geological Club, February 28, 1899. In considering the 'Law of the Migration of Divides,' Mr. J. M. Boutwell developed this law as stated by Cambell (*Journal of Geology*, IV, 580), and discussed the amendment to it

which has been offered by Smith (18th Annual Report, U. S. Geological Survey, Part II., 472).

Mr. H. T. Burr described 'A Drainage Peculiarity in Androscoggin, Maine.' Androscoggin Lake, the last of a chain which drain into Androscoggin River near North Leeds, Maine, contains a unique delta, which is situated, not at the head of the lake, but at the outlet.

The preglacial valley which the lake occupies is blocked just below the foot of the lake by glacial débris, which forces the outlet stream to flow backward, against the slope of the country, into the Androscoggin. Thus the fall between the lake and the Androscoggin is so small that at times of flood this main river rises so high as to reverse the flow of the outlet stream. At such times a flood of mud-laden water pours into the lake and deposits its load. Under normal conditions the outflow is incompetent to remove the material thus brought in. Accordingly the delta has grown, and is still growing, against the normal course of the current.

Geological Conference, March 7, 1899. Professor J. E. Wolff communicated his discovery of 'Hardystonite, a New Mineral from Franklin Furnace.' The specimen of ore containing the mineral came from a new working of the Parker Shaft, at about the nine-hundred-foot level. The mineral is tetragonal, and its general formula is $\text{ZnCa}_2\text{Si}_2\text{O}_7$. A complete description will be given in the Proceedings of the American Academy of Arts and Sciences.

Dr. Charles Palache described 'A Method of Enlarging Diagrams,' which has been developed in the Harvard Mineralogical Laboratory within the last few months. Its purpose is for preparing large diagrams, from small, straight-line, text diagrams, for lecture use. The instrument used is a megascope made by Fuess. This consists of two sets of three mirrors, which concentrate light upon the diagram. From that the light is reflected through a double-convex lens, which projects the image upon a screen. The diagram is then obtained by tracing the image, thus enlarged to any desired size, and by inking in this tracing. This method possesses a double advantage over photographic enlargements in that it affords a far more satisfactory product and is much cheaper.

Dr. A. S. Eakle presented 'Notes on Some Rocks from the Fiji Islands.' The collection, which included both igneous and sedimentary rocks from about twenty of the smaller volcanic islands, was made by Mr. Alexander Agassiz during his recent studies in that region. The specimens of eruptive rocks were found to include hornblende andesites, augite andesites, hypersthene andesites and basalts.

J. M. BOUTWELL,
Recording Secretary.

TORREY BOTANICAL CLUB, JANUARY 25, 1899.

DR. N. L. BRITTON presented a report on the progress of the New York Botanical Garden, with exhibition of photographs. Dr. Britton said that during 1898 the species cultivated in the Garden at Bronx Park have reached 2,110, a gain of 700 on the previous year. The fruticetum, on the plain northeast of the Museum building, was begun in October, and now includes 195 species. The arboretum has been increased to 178 species, including those native to the tract. A viticetum is in preparation, to be planted next spring, including rock-ledges, and a rustic arbor about 600 feet long, now nearly completed. An additional nursery space near the southern corner of the tract was prepared in the spring, and planted partly with Siberian cuttings. Border screens are now planted around the entire tract except to the south. A complete record of all plants grown is kept by means of a card catalogue. From every plant which flowers on the ground an herbarium specimen is made; and these are classified in a special herbarium, useful already in satisfying inquiries. The use of the greenhouse on the Columbia University grounds at Morningside Heights was granted in 1896, and is still very important to the Garden. This is the old greenhouse built in 1857 by Mr. S. Henshaw for the Bloomingdale Asylum, and is one of the oldest greenhouses still standing in the United States.

Progress on the Museum building has been active, and it is thought it will be ready for occupation by midsummer. The Power House is nearly ready to put into operation. A subway from this to the Museum is under construction. A stable, toolhouse, etc., have been

finished. The range of horticultural houses is planned to contain 13 houses; the contract for 7 of these has been signed, and ground was formally broken for them on January 3, 1899. Important work has been done toward improving the drainage of the Herbaceous Grounds, and a great deal of grading, and the terraces about the Museum have been begun. The Lorillard Mansion is now used as a police station-house, occupied by more than 65 officers, making a new and wholesome water-supply necessary. This has now been finished.

The Hemlock Forest remains in healthy condition; only three trees have died in the last three years.

The Museum is planned to provide in the basement a lecture-room seating 900; on the first floor a collection of plant-products, with models and photographs; on the second, a scientific collection for expert use, including a mounted collection of the local flora on swinging panels; followed by herbarium and laboratories on the top floor.

The herbarium already includes 30,000 specimens. Through the liberality of Mr. Cornelius Vanderbilt, Mr. and Mrs. Heller are now making collections in Porto Rico. Messrs. P. A. Rydberg and Ernest Bessey made collections in 1897 in Montana, through the liberality of Mr. W. E. Dodge. The results will soon appear as a Flora of Montana, forming the first volume of the Memoirs of the New York Botanical Garden.

E. S. BURGESS,
Secretary.

DISCUSSION AND CORRESPONDENCE.

SOME SUGGESTIONS FOR SCIENTIFIC SEMINARS AND CONFERENCES.

TO THE EDITOR OF SCIENCE: I feel that an experience of several years as a respectful and regular listener to scientific papers by young and old students, at college seminars or conferences, and at annual or periodic meetings of societies, gives me the basis for certain generalizations, without leaving me open to the criticism of judging from insufficient data.

The principal generalization I should like to offer is to the effect that our scientific students in colleges and professional schools do not re-

ceive sufficient training in the public presentation of their ideas, whether those ideas be original or borrowed. Most advanced scientific students in our colleges are obliged to attend and take part in seminars or conferences, at which their colleagues and teachers are supposed to criticise any scientific papers that may be presented. So far as my experience goes, the criticism is apt to be almost wholly as to scientific accuracy, with but little thought of several other points that are of vital importance. I fear teachers and professors are too apt to tolerate poor order, poor English and a 'dead-and-alive' manner of speaking, thinking the unfortunate beginner will gain wisdom by experience.

Judging from my own experience and the comments of others, I would say that our scientific workers often fail to carry their point and to win public sympathy for their work and cause because in their public utterances they do not follow rational lines of procedure. They are very apt: (1) to present an unorganized and apparently unrelated series of facts—their plan is rambling; (2) not to choose and emphasize the important points, probably because of lack of training in measuring the comparative worth of facts; (3) to use poor and inexcusable English; (4) to speak in a dazed sort of way, as though they themselves were not thoroughly convinced, as yet, of the truth of their results; (5) not to address the audience, a map or a blackboard under their influence being as inspiring as the audience, and much less embarrassing; (6) not to divide their time so as to complete their presentation within reasonable limits, thus causing weariness and restlessness on part of audience; (7) not to make good use of illustrative material in the way of maps, diagrams, specimens, lantern slides, etc.

Now the remedy for these serious failures that few men can outgrow seems to me to be largely in the hands of our college and scientific school teachers, and I would like to see a plan adopted in college seminars that would not allow a student to appear before his colleagues and masters until his plan of procedure had been censored, along the lines I have suggested, by some one of experience in public utterance.

The student should also receive criticism

after his paper, so as to bring out the weak points in his argument or manner, thus minimizing the possibility of an equal failure at his next appearance. Such criticism does not kill individuality, but strengthens it, and certainly gives the student a greater confidence in and respect for his teachers. Should our colleges and scientific schools uniformly adopt such a method of training, our scientific gatherings ten years hence would not be so largely composed of specialists and those who attend from duty and with considerable sacrifice. It would also be much easier to secure public support for scientific work were more of our leaders able to win the interest of the public, without becoming merely 'popular lecturers,' by whom scientific accuracy is apt to be sacrificed for the sake of impressiveness.

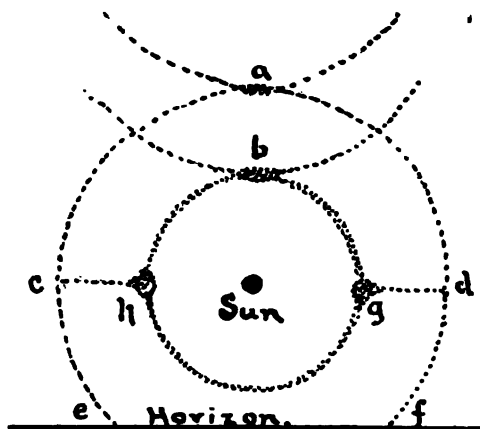
Such work as I have suggested for our teachers takes much time and energy and seems at first not to pay; but immediate returns are not always the best, and there is no work on the part of a teacher that can give greater satisfaction in the long run than that which has helped beginners to make the most of their latent powers.

RICHARD E. DODGE.

TEACHERS COLLEGE,
COLUMBIA UNIVERSITY.

A REMARKABLE SUN-DOG.

THE appended diagram is an attempt to record the appearance presented by a rare and remarkable 'sun-dog' seen at Hamline, Minnesota, at 9:50 a. m., on February 10th. It was a very



cold and damp morning; the air was not clear, and there was a film of thin clouds over all the sky. The weather records at St. Paul Observatory, five miles distant from Hamline, indicated, S. E. 6 miles per hour for the wind, 29.50 as the Barograph reading of the barometric pressure, and 20 degrees below zero as the thermograph reading of the temperature. The two 'sun-dogs' proper were *g* and *h* of the figure and were so brilliant that it was painful to look at them, and a line of intense light stretched from them outwards toward *d* and *c*. There were two circles surrounding the sun; one, the inner one, was complete; the other was nearly so, but dipped below the horizon. There were arcs of two circles turned from the sun at *a* and *b*, and at these points there was a display of prismatic colors. The large outer circle looked much like a rainbow, especially near the horizon. This latter fact seemed connected with the fact that there was almost moisture enough in the air to constitute a very fine snow.

H. L. OSBORN.

HAMLIN UNIVERSITY, ST. PAUL, MINN.,
February 20, 1899.

DEGREES IN SCIENCE AT HARVARD UNIVERSITY.

HARVARD UNIVERSITY conferred for the first time last year the degree of 'Master of Science.' As the creation of this degree appears at first sight to be a new recognition of science, it may be desirable to point out that there are aspects under which it is, in fact, harmful to science and a retrograde movement in that university to which we look for guidance. It is, indeed, logical to have a degree between the S. B. and S. D. parallel to the A. M., but it would be equally logical and, in my opinion, far better to abolish the S. B. and S. D.

The composition of the Lawrence Scientific School of Harvard University is not made less heterogeneous by giving all its graduates the same degree. Some of the students are pursuing studies in applied science exactly parallel to those of the schools of medicine, law and theology, and should on graduation be given a technical degree signifying the profession that they have been trained to practice, *i. e.*, C.E., civil engineer, etc. Others of the students are following the same scientific studies as may be elected

by students of the college who receive the A.B. The difference is that the Lawrence Scientific School may be entered with an inadequate preparation. Fortunately, plans have been adopted that will gradually raise the requirements for admission to the Scientific School to substantial equality with those of the college. At present consequently the S. B., in its sense of a liberal education based upon science, means, as compared with the A. B. for the same studies, an inadequate preparation; later it will signify a secondary education without Latin.

Students of Harvard College, as of the Great English universities, may now take the A.B. without any study of Latin or Greek at the University. This freedom of election has, as President Eliot points out in his last annual report, maintained at Harvard the relative numerical importance of the traditional degree better than in any other American institution. The A.B. is becoming almost obsolete in our great State universities. Thus at California last year among 191 bachelors only 30 were in arts, at Wisconsin among 173 only 13, etc. I regard this as unfortunate as the Ph.B. and S.B. at these universities means simply a liberal education without Greek or without Latin and Greek. It seems to me more consistent to give the A.B. for liberal studies as is done at Harvard, Johns Hopkins, Columbia, Cornell and the English universities. But of these universities only Cornell is sufficiently logical to admit that a liberal education is possible without 'small Latin' in the preparatory school. President Eliot will anticipate the course of educational progress, as he has so often done, if he will transfer the required study of English to the preparatory school, as he aims to do, and will secure the admission of students to Harvard College without Latin. The S.B., S.M. and S.D. would then be superfluous as degrees for liberal studies. I regard them as useless altogether, except that it might be desirable to give the Sc.B., simultaneously with a technical scientific degree and to maintain Sc.D. and Litt.D. as honorary degrees. In the English universities Sc. refers to science, while B.S. and M.S. refer to surgery, consequently Sc. rather than S. should be used.

At Harvard the A.M. and the Ph.D. are

given for advanced work to Bachelors of Arts, and the S.D., and since last year the S.M., to Bachelors of Science. The S.D. is given for exactly the same, scientific research and study as the Ph.D., and means the same thing, except that it is in addition a certificate of a poor preparatory education. It is no wonder that it is not popular, having been awarded only once in the past three years, while the Ph.D. has been awarded sixty-nine times. If a student comes to Harvard from a Western university, having studied Latin throughout his college course and received a Ph.B., he is apparently not eligible for the Ph.D. What would be done with a student coming with the A.B. from Cornell, but never having studied Latin, I do not know. The maintenance at Harvard of the S.M. and S.D. as second-rate degrees appears to be a needless limitation of the usefulness of its graduate school, and a wounding of science in the house of its friends.

J. McKEEN CATTELL.

COLUMBIA UNIVERSITY.

SCIENTIFIC APPOINTMENTS UNDER THE GOVERNMENT.

WE have received notice of civil service examinations as follows:

On May 9th for Assistant Chief, Division of Agrostology, Department of Agriculture. (Salary \$1,800 per annum.) The subjects and weights are as follows:

1. Agrostology.....60
2. Replies to letters on agrostology.....10
3. German and French translation.....10
4. Botany (major), or Chemistry (minor), (See Section 67, 'Assistants, Department of Agriculture, Departmental Service,' page 45 of the Manual of Examinations, revised to January 1, 1899).....20

At the same time an examination will be held for the position of Assistant in the Division of Agrostology at a salary of \$1,200. The subjects and weights being:

1. Agrostology.....50
2. Translation from one foreign language (Spanish, French, German, or Italian).....15
3. Latin translation 5
4. Botany (minor), (See section 67, 'Assistants, Department of Agriculture, Departmental Service,'

page 35 of the Manual of Examinations, revised to January 1, 1899).....15

5. Education and experience15

On May 1st an eligible register will be established for the position of Irrigation Expert, office of Experiment Stations, Department of Agriculture, at a salary of \$2,500 per annum. Subjects and weights are as follows:

1. A statement of the education, training and technical experience of the competitor.....30
2. A statement of the competitor's experience as an administrative officer, with special reference to irrigation laws and regulations.....30
3. A thesis of not less than three thousand words on a topic relating to irrigation20
4. A statement of not more than three thousand words setting forth a plan of irrigation investigations in the arid regions of the United States for the benefit of the farmers of those regions.....20

It will not be necessary for applicants to appear at any place for examination, but the statements and theses required may be prepared by the competitors at their homes upon forms which will be furnished by the United States Civil Service Commission upon request. Competitors will be required to furnish sworn statements as to the integrity of the work submitted by them.

Under similar conditions and on the same day an eligible register will be established for the position of tobacco expert to the Department of Agriculture. The subjects and weights are as follows:

1. Experience, including complete statement of personal experience in connection with the development of the tobacco industry of Florida.....30
2. Administrative ability, including a full statement of personal experience in the administration of work connected with the growth, purchase, manipulation and marketing of the Florida tobacco.....30
3. Two theses, of two thousand to four thousand words in length, on subjects relating to the tobacco industry.....40

On May 9th and 10th an examination will be held for the position of computer in the Nautical Almanac office, the subjects and weights being:

1. Algebra15
2. Geometry.....10
3. Plane and spherical astronomy.....20
4. Elements of differential and integral calculus 10

5. Logarithms25
 6. Spherical astronomy.....20

Further information regarding these positions and blanks for applications may be obtained from the U. S. Civil Service Commission, Washington, D. C.

SCIENTIFIC NOTES AND NEWS.

THE National Academy of Sciences will hold its stated annual meeting, beginning on Tuesday, April 18th.

AT the annual meeting of the Astronomical Society of the Pacific on March 25th the second award of its Bruce Gold Medal was announced. It was conferred upon Dr. Arthur Auwers, of Berlin.

SIR WILLIAM TURNER, professor of anatomy in the University of Edinburgh, has been elected President of the British Association for the Bradford meeting of 1900.

It is announced that Mr. Llewellyn W. Longstaff, a member of the Royal Geographical Society of London, has contributed \$125,000 towards the fund for the British Antarctic expedition.

DR. L. L. HUBBARD has resigned the position of State Geologist of Michigan. The *American Geologist* states that he has taken this action owing to the delay of the State Board of Auditors in authorizing the publication of the Reports of the Survey.

DR. E. V. WILLCOX has resigned his position as zoologist and entomologist in the Montana Agricultural College and Station to accept a position in the office of Experiment Stations in the place of Dr. F. C. Kenyon, resigned. Dr. Willcox will have charge of the departments of zoology, entomology and veterinary science of the *Experiment Station Record*.

MR. LE GRAND POWERS, of Minnesota, has been appointed Chief Statistician in charge of agricultural statistics, and Mr. William C. Hunt, of Massachusetts, has been given charge of the statistics of population in the twelfth census. Mr. Hunt held the same position in the census of 1890. Mr. Powers is Chief of the Minnesota Bureau of Labor.

M. FILHOL has been elected an associate of the Paris Academy of Medicine in the place of

the late Dr. Worms. M. Filhol is a member of the Paris Academy of Sciences, and has published important memoirs in anatomy, zoology and paleontology.

PROFESSOR LUIGI CREMONA, professor of mathematics at the University of Rome, and Professor Alexander Karpinski, St. Petersburg, Director of the Russian Geological Survey, have been elected foreign members of the Belgian Academy of Sciences.

DR. T. GRIGOR BRODIE, lecturer on physiology at St. Thomas's Hospital Medical School, has been nominated by the Laboratories Committee of the Royal Colleges of Physicians and Surgeons to be Director of the Research Laboratories on the Thames Embankment.

MR. E. E. GREEN, the well-known Ceylon entomologist, has been appointed Government Entomologist on the staff of the Agricultural Department of that island, with residence at the Royal Botanic Gardens, Peradeniya. He is about to visit England, and will return to Ceylon to take up his work about September. For many years Mr. Green has been doing admirable work on the insects of Ceylon, with especial regard to injurious species, and a better selection could not have been made for the new position.

DR. WALTER R. HARPER, of Sydney, New South Wales, starts this month on a trip in the New Hebrides to investigate the somatology and folk-lore of that group. We are informed by him that the museums of Australia, although new, have already secured some remarkable collections representative of Australian ethnology. The museum at Sydney, under the curatorship of R. Etheridge, and the one at Adelaide in charge of Dr. Stirling, are especially good owing to the interest of their curators in ethnology. Lately the Western government sent a collecting party into the interior under the leadership of Mr. Alex. Morton, Curator of the Tasmanian Museum. This expedition was successful and secured among other things a series of carved bull-roarers, which are sacred objects there. Lack of funds hampers the work in Australia as elsewhere, and the field is yet largely unknown. Much valuable material remains to be investigated even in the Eastern

colonies, while Northwest Queensland is especially rich.

MR. HJALMAR LUNDBOHM, of the Geological Survey of Sweden, is now in the United States, with a view to studying the deposits of iron ore.

DR. BENJAMIN M. DUGGAR, instructor in botany (plant physiology) at Cornell University and Assistant Cryptogamic Botanist of the Experiment Station, sailed on March 22d from New York for Europe. He will spend the year abroad in study, principally with Dr. Pfeffer in the laboratories for plant physiology at Leipzig, and with Dr. George Klebs. He will attend the meeting of the British Association for the Advancement of Science during September. Mr. Duggar received the degree of Doctor of Philosophy at Cornell University last June. He will return in a year to resume his work at Cornell.

A MARBLE bust of the late I. H. Lapham, the geologist, was, as we learn from the *American Geologist*, unveiled in the public museum of Milwaukee on March 7th. It was presented by Mr. John Marr. Several addresses were made, including one on the life and work of Lapham by Mr. John Johnston.

A MONUMENT to Pasteur will be unveiled and a Pasteur Institute opened at Lille on April 9th.

A MONUMENT will be erected in October to Charles Marc Sauria, said to be the original inventor of lucifer matches, at St. Lothair, a small village in the Jura, where he spent his life as a country physician.

DR. ANGELO KNORR, docent in the Veterinary School of Munich, died on February 22d, from acute glanders contracted in the course of an experimental research on mallein.

MISS ELIZABETH BROWN, of Cirencester, England, who made valuable contributions to astronomy, died on March 6th. She observed the total eclipses of the sun in 1887, 1889 and 1896, and had published both scientific and popular accounts of the solar phenomena.

WE regret also to record the deaths of Dr. Wilhelm v. Müller, professor in the Institute of Technology and member of the Academy of Sciences of Munich; of Dr. Friedrich v. Lüh-

mann, the mathematician, at Stralsund; of Dr. Charles Fortuun, the mineralogist, in London, and of P. v. Alfr. Feuilleaubeis, known for his researches on fungi, at Fontainebleau.

A REUTER dispatch, dated March 16th, states that the steamer 'Southern Cross' has arrived at Port Chalmers from Victoria Land, where she landed M. Borchgrevink and the other members of the Antarctic expedition. The explorers are 11 in number.

MR. A. W. ANTHONY and his party, who have been making collections for the Smithsonian Institution, have been wrecked off the coast of Lower California. No lives were lost, but the collections could not be saved.

THE Union Pacific Railway offers to transport geologists and paleontologists without charge from Chicago or San Francisco to Wyoming, for the purpose of making explorations during the coming summer.

AN expedition under Lieutenant Koslow is being sent by the Russian Geographical Society to make explorations in Central Asia. It will cross the Nanschu Mountains and explore the upper waters of the Yellow River.

M. H. R. DUMONT has left to the Paris Society of Geography a travelling fund that will yield 1,000 fr. per annum.

A RADIOGRAPHIC institute has been opened at Madrid under the direction of Dr. Mezquita. It is said to have cost \$400,000.

THE French Congress of Learned Societies met at Toulouse on April 4th under the presidency of M. Levasseur.

AT the March meeting of the French Astronomical Society M. Cornu made an address on the applications of physics to astronomy. M. Flammarion, the Secretary, reported that a number of astronomers had written saying that they had seen the phases of Venus with the naked eye, the possibility of which has been denied. The air throughout Europe has been unusually clear for a long time.

THE first international congress of physicians connected with life insurance companies will be held at Brussels from the 25th to the 30th of next September. All Europe and the United States will be represented at this congress,

which proposes to establish universal formulas for the examination of persons desiring to be insured.

ON March 18th the Austrian Society of Engineers celebrated its jubilee in the Municipal Council Chamber, Vienna, under the presidency of Mr. F. Berger. *Nature* says that there was a large attendance of members, and representatives of sixty six kindred societies presented addresses. Congratulatory speeches were delivered by the Austrian Minister of Railways; the Minister of Commerce; the Governor of Lower Austria; the Secretary of the Iron and Steel Institute, London; the Secretary of the French Society of Civil Engineers, Paris, and the Secretary of the Society of German Engineers, Berlin. A paper was then read by Mr. A. Rücker on the part taken by the Austrian Society of Engineers in the technical progress of the past fifty years. The Austrian Society is a very influential one. At its foundation in 1848 it numbered seventy-nine members; at the present time there are 2,388.

THE inaugural course of the Charles F. Deems lectureship foundation will be given by Professor James Iverach, D.D., of Aberdeen, on Mondays and Wednesdays at 10:30 a. m., beginning on April 3d at University Building, Washington Square. The endowment of \$15,000 given by the American Institute of Christian Philosophy to the New York University provides for lectures on science and philosophy in their relation to religion.

MR. RITCHIE, President of the British Board of Trade, received at the House of Commons on March 22d a deputation of representatives from the Decimal Association, chambers of commerce, educational institutions and trade unions, who urged upon the government the compulsory adoption of the metric system of weights and measures on January 1, 1901. The importance of this measure was urged by Sir Samuel Montague, Sir Henry Roscoe, Sir E. S. Hill and others. Mr. Ritchie in reply said that the government had done much by making the metric system legal and by introducing it in the schools, but did not think that public opinion warranted its compulsory adoption. The resolutions passed by the associated chambers of commerce was as

follows: "That, in view of the time wasted in teaching a system of weights and measures which, according to the First Lord of the Treasury, is 'arbitrary, perverse and utterly irrational,' and in the opinion of Her Majesty's Consuls is responsible for great injury to British trade, this association urges Her Majesty's government to introduce into and endeavor to carry through Parliament as speedily as possible a bill providing that the use of the metric system of weights and measures shall be compulsory in this country within two years from the passing of the bill, and suggests that meanwhile the system should be adopted in all specifications for government contracts."

THE Eclipse Expedition to Japan under Professor Todd, two years ago, founded at Esashi a public library, in return for courtesies shown the expedition. Professor Todd is now sending to this library, through the legation at Washington, a collection of books part of which have been given by a number of representative American publishers.

THE original manuscripts of surveys of Van Diemen's Land, made between 1821 and 1836, were sold recently at the rooms of Messrs. Hodgson, London, for \$250.

THE Compagnie Générale Transatlantique is establishing a service of carrier pigeons, which it is believed will announce the arrival of steamships twelve hours earlier than is at present possible.

Nature states that a dinner which took place at the Fishmongers' Hall on March 14th possesses especial interest on account of the fact that it was given in honor of science, and that the guests included a great number of scientific men, among them being the Presidents of the following societies and scientific bodies: Royal, Royal Horticultural, Royal College of Physicians, Royal Geographical, Dermatological, Royal Microscopical, Victoria Institute, Royal Statistical, Royal College of Surgeons, Royal Astronomical, Zoological, Linnean, Chemical, Entomological, Philological and Clinical. The toast of the evening was 'Science,' and was proposed in an eloquent speech by the Prime Warden, Mr. J. A. Travers, who pointed out the great advance science had made in the last

twelve years; he recommended, further, the special study of preventive medicine, to ensure for Great Britain a safer footing in foreign climates. Lord Lister responded to the toast, and urged City Companies to support pure science; he referred also to the help they had rendered the Jenner Institute. Sir William MacCormac then proposed the health of the Prime Warden.

THE *Railway and Engineering Journal* reports that the War Department is arranging to make a test of the Marconi system of wireless telegraphy. The two experimental stations selected are the roof of the State, War and Navy Building and Fort Myer, across the Potomac, the distance being six miles. The government has purchased the necessary instruments and experiments will be conducted by Col. James Allen and Lieut. George D. Squire.

At a recent meeting of the Royal Geographical Society a paper on 'Exploration in the Canadian Rockies: A Search for Mount Hooker and Mount Brown' was read by Professor Norman Collie, F.R.S. According to the *London Times* Professor Collie's paper dealt with two journeys taken during 1897 and 1898 through that part of the Canadian Rockies that lies between the Kicking Horse Pass on the south and the source of the Athabasca River on the north. The most interesting problem connected with the first journey which presented itself to Professor Collie and his party was whether a lofty mountain—probably 14,000 ft. to 15,000 ft.—seen from the slopes of Mount Freshfield, from which it lay distant about 30 miles in a north-westerly direction, might be Mount Brown or Mount Hooker, which were supposed to be 16,000 ft. and 15,000 ft. high respectively. Professor Coleman, in 1893, starting from Morley, had arrived at the true Athabasca Pass, found the historic Committee's Punch-bowl, and his brother had climbed the highest peak on the north, presumably Mount Brown. This peak he found to be only 9,000 ft. The question presented itself: Could he have been mistaken or was it possible that there existed two Athabasca Passes? Professor Collie and his companion returned to their camp on the Saskatchewan Pass without having solved the question of either

Mounts Brown or Hooker, or the Committee's Punch-bowl. It was finally settled on the return to England by reference to the journal of David Douglas, the naturalist, dealing with his journey over the Athabasca Pass. From the authentic account of the two mountains there given it was seen that the credit of having settled with accuracy the real height of the peaks belonged to Professor Coleman. For nearly 70 years they had been masquerading in every map as the highest peaks in the Rocky Mountains. No doubt now remained as to where Brown and Hooker and the Punch-bowl were. That Douglas climbed a peak 17,000 ft. high in an afternoon (as narrated in his account) was impossible; the Mount Brown of Professor Coleman, 9,000 ft. high, was much more likely. There was only one Athabasca Pass, and on each side of its summit might be found a peak—Mount Brown, 1,000 ft. high, on the north—the higher of the two—and Mount Hooker on the south. Between them lay a small tarn, 20 ft. in diameter—the Committee's Punch-bowl. The peaks to the south, amongst which the party wandered last August, were, therefore, new, and they probably constituted the highest point of the Canadian Rocky Mountain system.

THE *British Medical Journal* states that the tenth meeting of the International Congress of Hygiene will be held in Paris in August, 1900. The division of hygiene will comprise seven sections as follows: 1. Microbiology and Parasitology applied to hygiene. M. Laveran is President and M. Netter Secretary of this Section, in which the questions to be discussed are the measurement of the activity of serums; the prophylaxis and preventive treatment of diphtheria; meat poisoning, its causes and the means of its prevention; pathogenic microbes in soil and water (cholera, typhoid fever and other diseases); the part played by water and by vegetables in the etiology of intestinal helminthiasis. 2. Chemical and veterinary sciences applied to hygiene; alimentary hygiene, in which the questions to be discussed are tinned provisions and the means of preventing accidents; unification of international control; the establishment of a general and uniform system of inspection of slaughter houses, etc. 3. En-

gineering and architecture applied to hygiene, in which the question to be discussed is the protection of water supplies. 4. Personal hygiene, in which the question to be discussed is contagious patients from the hospital point of view. 5. Industrial and professional hygiene. 6. Military, naval and colonial hygiene, in which the question to be discussed is the means of ensuring the purity of water from the point of view of colonial hygiene. 7. General and international hygiene (prophylaxis of communicable diseases; sanitary administration and legislation), in which the questions to be discussed are the prophylaxis of tuberculosis in regard to individuals, families, etc.; the compulsory notification of communicable diseases, its necessary consequences (isolation, disinfection) and its results in different countries; the prophylaxis of syphilis; and the international prophylaxis of yellow fever.

UNIVERSITY AND EDUCATIONAL NEWS.

MR. JOHN D. ROCKEFELLER has offered \$100,000 to Denison University, Granville, O., if the friends of the institution will, within the next year, raise the sum of \$150,000.

MRS. SIMON REID, of Lake Forest, has expressed her intention of giving to Lake Forest University a chapel and a library.

THE further sum of £25,000 has been offered for the Birmingham University on condition that £225,000 are obtained within a year. The amount already promised is £135,000.

PROFESSOR LOUIS F. HENDERSON, professor of botany in the University of Idaho, at Moscow, Idaho, has recently donated to the botanical department of Cornell University a complete set of his duplicates of the phanerogams and ferns of Idaho. Over 900 species were contained in the collection, making it one of the most valuable single local collections that the University has received. Professor Henderson is an alumnus of Cornell University, class of '74.

PROFESSOR W. V. BRANCO, of Hohenheim, has been called to the chair of geology and paleontology in the University of Berlin, as successor to Professor Dames.

CHARLES EDWARD ST. JOHN, PH.D., has been appointed to the professorship of physics and astronomy in Oberlin College.

MR. JOSEPH BARCROFT has been elected Fellow of King's College, Cambridge. His chief work has been in physiology.

ALEXANDER ANDERSON, professor of natural philosophy in Queen's College, Galway, has been appointed President of the institution.

It is said that the candidates for the chair of physiology at Edinburgh, vacant by the death of Professor Rutherford, include Professor E. A. Schäfer, Dr. William Stirling, Dr. D. N. Paton, Dr. E. Waymouth Reid, Dr. E. W. W. Carlier and Dr. G. N. Stewart.

M. HENRI MOISSAN has published for the Council of the University of Paris a report on its work during the year 1897-8. The increase in the number of students at periods of six years is shown in the accompanying table:

	1886-86.	1891-92.	1897-08.
Medicine.....	3.696	4.250	4.494
Law.....	3.786	4.111	4.607
Pharmacy.....	1.767	1.547	1.790
Letters.....	928	1.185	1.989
Sciences.....	467	655	1.370
Protestant Theology...	35	36	95
Total.....	10.679	11.784	14.346

It will be noticed that the growth in the number of students of science is the greatest, and the increase has been more than maintained during the present year, being 127 as compared with 85 in letters. It should be recollected that there are many important institutions for higher education in Paris—The Collège de France, The Museum of Natural History, The School of Mines, the Normal College, The Polytechnic Institute, The School of Fine Arts, The Pasteur Institute, etc.—not included in the University. Paris is thus certainly the world's largest educational center, but the provincial universities are less important than the corresponding institutions in other countries. The gifts to the university during the year, about \$30,000, appear small in comparison with those to American institutions. There are only 202 scholarships, which is also relatively fewer than in America and in Great Britain.

SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; J. LE CONTE, Geology; W. M. DAVIS, Physiography; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; HENRY F. OSBORN, General Biology; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; J. MCKEEN CATTELL, Psychology; DANIEL G. BRINTON, J. W. POWELL, Anthropology.

FRIDAY, APRIL 14, 1899.

A SAGE IN SCIENCE.*

CONTENTS:

<i>A Sage in Science: PRESIDENT DAVID STARR JORDAN.....</i>	529
<i>Field-Work of the Jeap North Pacific Expedition in 1898:—</i>	
<i>The Indians of Western Washington: DR. LIVINGSTON FARRAND. Archaeological Investigations on the North Pacific Coast of America: HARLAN I. SMITH. Archaeological Investigations on the Amoor River: GERAUD FOWKE.....</i>	532
<i>On Biological Text-Books and Teachers: O. F. COOK.....</i>	541
<i>Scientific Books:—</i>	
<i>Hastings and Beach's Text Book of General Physics: PROFESSOR J. S. AMES. Marr's Principles of Stratigraphical Geology: PROFESSOR HENRY S. WILLIAMS. Mason on the Examination of Water: PROFESSOR EDWIN O. JORDAN. A Monograph of the North American Potentillae: CHARLES E. BESSEY.....</i>	545
<i>Scientific Journals and Articles.....</i>	549
<i>Societies and Academies:—</i>	
<i>The Scientific Alliance of New York. Geological Society of Washington: DR. W. F. MORSELL. The Philosophical Society of Washington: E. D. PRESSION. Physics Club of New York: A. T. SEYMOUR. Sub-section of Anthropology and Psychology of the New York Academy of Sciences: PROFESSOR CHARLES H. JUDD.....</i>	550
<i>Discussion and Correspondence:—</i>	
<i>'The Evolution of Modesty:' HIRAM M. STANLEY. Transmitted Characteristics in a White Angora Cat: DR. JOHN W. HARSHBERGER. Osmotic Solutions: PROFESSOR G. MACLOSKIE</i>	553
<i>Notes on Physics:—</i>	
<i>Wireless Telegraphy: F. C. C.....</i>	555
<i>Botanical Notes:—</i>	
<i>An Elementary Book on Lichens; A Texas School of Botany; False 'Aids' in Botany; Minnesota Botanical Studies: PROFESSOR CHARLES E. BESSEY.....</i>	555
<i>The Brain of Hermann von Helmholtz.....</i>	557
<i>Scientific Notes and News.....</i>	557
<i>University and Educational News.....</i>	559

BROOKS' lectures on the Foundations of Biology constitute a book that will live as a permanent addition to the common sense of science. It belongs to literature as well as to science. It belongs to philosophy as much as to either, for it is full of that fundamental wisdom about realities which alone is worthy of the name of philosophy. Writers of literature have been divided into those with quotable sentences, as Emerson and Thoreau, and those whose style runs along without break in the elucidation of matter in hand, as Hawthorne and Irving. To the former class Brooks certainly belongs. His lectures are full of nuggets of wisdom, products of deep thought as well as of careful observation. There is not an idea fundamental to biology that is not touched and made luminous by some of these sagacious paragraphs. Whether it be to show the significance of some unappreciated fact, or to illustrate the true meaning of some complex argument, or to brush away the fine-spun rubbish of theory, the hand of the master is seen in every line.

The main lesson of the work is that to believe is not better or nobler or higher

* The Foundations of Zoology, by William Keith Brooks, Ph.D., LL.D., professor of zoology in the Johns Hopkins University. A course of lectures delivered at Columbia University on the Principles of Science illustrated by Zoology. New York, The Macmillan Company, 339 pages; price, \$2.50.

MSB. intended or publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

than to know. Belief adds nothing to certainty, and whatever is really true is the very best thing that could be true, else it had not been so. Dr. Brooks sees no reason for hoping, fearing or wishing in regard to truth. So long as it is true we can ask nothing better, and no new truth can be subversive of anything worth keeping in our previous stock of beliefs and inductions.

Dr. Brooks shows in many cases that problems over which scientific men have worried for years without result are at bottom mere questions of words. The facts at issue are recognized by all, but the matter of their final interpretation is one of the ultimate truths which science can never find out, for man can come in contact with no ultimate truth of any sort.

There is another class of problems which can never be settled by argument. We must wait until we know the truth. One of these concerns the existence of a principle of life which distinguishes vital processes from the operations of ordinary chemistry and physics. "Many biologists," says Brooks, "find their greatest triumph in the doctrine that the living body is a 'mere machine;' but a machine is a collocation of matter and energy working for an end, not a spinning toy; and when the living machine is compared to the products of human art the legitimate deduction is that it is not merely a spinning eddy in a stream of dead matter and mechanical energy, but a little garden in the physical wilderness; that the energy localized in *living* bodies, directed by similarly localized *vitality*, has produced a collocation of other material bodies which could not be brought about in a state of physical nature, and that the distinction thus drawn between the works of non-vital nature and those of life is both useful and justifiable. What this distinction may mean in ultimate analysis I know no more than Aristotle and Huxley;

nor do I believe that any one will ever know until we find out. One thing we may be sure of, that it does not mean that the living world is anything but natural." Here he quotes from Aristotle, "That is natural *which holds good*, either universally or generally." If anything occurs, it is, therefore, natural.

"Faith and hope are good things, no doubt," says Dr. Brooks, "and 'expectation is permissible when belief is not;' but experience teaches that the expectation or faith of the master is very apt to become belief in the mind of the student, and 'science warns us that the assertion that outstrips evidence is not only a blunder but a crime.'" The key-note to the series of lectures is found in the introductory sentence that "life is response to the order of nature." "I should like to see hung," he says, "on the walls of every laboratory Herbert Spencer's definition to the effect that life is not protoplasm but adjustment; or the older teaching of the father of zoology, that the essence of a living thing is not what it is made of nor what it does, but why it does it."

The study of biology is the study of response and adaptation. The study of structure is the consideration of concessions to environment. The phases in development are related to the stimuli, external or internal, on which they are conditioned.

"It follows that biology is the study of response, and that the study of that order of nature to which response is made is as well within its province as the study of the organism which responds, for all the knowledge we can get of both these aspects of nature is needed as a preparation for the study of that relation between them which constitutes life."

The long dispute as to the inheritance of acquired characters is fairly closed by the words of Dr. Brooks. The arguments drawn from philosophical or analogical considerations are all brushed away, and

we are brought to the plain fact that no such inheritance is yet known to take place, and no one can yet say that it does not. "I find," he says, "as little value in the *a priori* arguments of those who hold that 'acquired characters' cannot be inherited as I find in Haeckel's assertion that 'belief in the inheritance of acquired characters is a necessary axiom of the monistic creed.'" In other words, *a priori* arguments are simple expansions of definitions or assertions, and can have no validity beyond that of the statements from which they are drawn. There is no truth to be derived from argument, *a priori*. If it is truth it is already known and needs no argument.

Dr. Brooks sums up his final conclusion that, whether "it be a real factor or not, the so-called Lamarckian factor (inheritance of acquired characters) has little value as a contribution to the solution of the problem of the origin of species, and renewed study has strengthened this conviction."

Dr. Brooks has a suggestive and valuable chapter in reproof of those who would place the law or principle of evolution as something apart or above the forces which are known to bring about orderly change or adaptation in living organisms.

"The tendency to regard natural selection as more or less unnecessary or superfluous, which is so characteristic of our day, seems to grow out of reverence for the all-sufficiency of the philosophy of evolution, and pious belief that the history of all living things flows out of this philosophy as a necessary truth or axiom.

"As no one can say that the basis for it [the philosophy of evolution] is not true, and as it seems much more consistent with scientific knowledge than any other systems of philosophy we must admit that, for all we know to the contrary, it may be true; and we may ask whether, if true, it is any substitute for science; although we must remember that there is no end to the

the things which, while no one treats them seriously, may nevertheless be true. * * * While anything which is not absurd may be good poetry, science is founded on the rock of evidence.

"So far as the philosophy of evolution involves belief that nature is determinate or due to a necessary law of universal progress or evolution, it seems to me to be utterly unsupported by evidence and totally unscientific.

"Men of science repudiate the opinion that natural laws are rulers and governors over nature; looking with suspicion on all 'necessary' or 'universal' laws."

Again he says, "Natural laws are not rulers or governors over nature, but generalizations from an experience which seems to teach, among other things, that progress is neither necessary nor universal.

"The hardest of intellectual virtues is philosophic doubt, and the mental vice to which we are most prone is our tendency to believe that lack of evidence for an opinion is a reason for believing something else. This tendency has value in practical matters which call for action, but the man of science need neither starve nor choose."

Most suggestive chapters are those on the mechanism of nature with reference to Paley's famous argument for design in nature, and the varied changes which the argument for teleology has undergone. There is a constant plea against reading into the relations of nature more than is actually seen there, as also against the denial of that which may occur and yet has not been actually seen.

"We can give no reason why life and protoplasm should be associated except the fact that they are. And is it not equally clear that this is no reason why they may not exist separately?" In this connection we are given a charming analysis of the idealism of Agassiz, with the reason why

his wide-reaching suggestions have found so little favor among later naturalists.

"In order to prove that natural history is a language which we learn and listen to, to our entertainment and profit and instruction, he holds it essential to prove that it is *nothing but* a language; that the relations between living things and the world about them, being ideal relations, cannot possibly be physical ones also; that our 'laws of biology' are not 'necessary' but 'arbitrary.'"

The belief in Monism which Haeckel places first in his articles of scientific faith naturally wakens in Dr. Brooks little response. It is a philosophical expression wholly unrelated to reality. Whether it is the highest of all possible human generalizations or a mere play on words, science has no means of deciding, and man has no other court of appeal save his own experience.

I have already reached the limit of my space, while the majority of the passages I had marked for quotation are still untouched. The stones which Dr. Brooks has chosen as 'Foundations of Zoology' will remain there for centuries, most of them as long as human wisdom shall endure. The volume is a permanent contribution to human knowledge, the worthy crown of a life of wise thought as well as of hard work and patient investigation. If there are any errors in statement or conclusion, from one end of the book to the other, the present writer is not astute enough to find them out, and Dr. Brooks' logic may permit him at least to doubt their existence. •

The biologists of America have long since recognized Dr. Brooks as a master, and this volume, the modern and scientific sequel to Agassiz's 'Essay on Classification,' places him in the line of succession from the great interpreter of nature, whose pupil and friend he was. DAVID STARR JORDAN.

STANFORD UNIVERSITY.

FIELD-WORK OF THE JESUP NORTH PACIFIC EXPEDITION IN 1898.

THE Jesup North Pacific Expedition was organized in 1897 by Mr. Morris K. Jesup, President of the American Museum of Natural History, for the purpose of investigating the ethnology and archæology of the coasts of the North Pacific Ocean between the Amoor River, in Siberia, and Columbia River, in North America, the whole expense of the expedition being defrayed by Mr. Jesup.

During the year 1897 the field-work of the expedition was confined to the coast and interior of British Columbia. In 1898 the work was taken up on a more extended scale. Parties were in the field on the coast of the State of Washington, in the southern interior of British Columbia, on the coast of British Columbia, and on the Amoor in Siberia. On both continents ethnological work as well as archæological work has been done. While the parties in charge of the work on the American continent returned with the beginning of the winter, the work in Asia is being carried on.

The collections made by the various field parties of the expedition in 1897 are now on exhibit in the American Museum of Natural History. These collections represent the results of archæological work in the interior of British Columbia and on the coast. The ethnological collections are particularly full in regard to the tribes of Thompson River, of northern Vancouver Island, and of the central parts of the coast of British Columbia. The Museum has commenced the publication of the scientific results of the expedition in the form of memoirs. Up to this time two numbers have been issued—'Facial Paintings of the Indians of Northern British Columbia,' and 'Mythology of the Bella Coola Indians,' both by Franz Boas. Other results of the explorations in 1897 are in preparation, and will be issued in the course of the year.

Among these are the results of archaeological work in the interior of British Columbia, by Harlan I. Smith; a description of the Thompson River Indians, by James Teit; and a discussion of conventional art among the Salish tribes, by Livingston Farrand.

The field-work of the expedition during 1898 was in the hands of Dr. Livingston Farrand and Mr. Roland B. Dixon, in the State of Washington and in southern British Columbia. The archaeological work in British Columbia has been carried on by Mr. Harlan I. Smith. Investigations on the Indians of the southern interior of British Columbia were continued by Mr. James Teit. The ethnological work on the Amoor River, more particularly among the Gilyak, was carried on by Dr. Berthold Laufer, and archaeological investigations in the same region were in the hands of Mr. Gerard Fowke. Following is a statement of the outline of the work of these parties, so far as available at the present time.

THE INDIANS OF WESTERN WASHINGTON.

In the plan of operations of the expedition along the northwest coast of the continent there was included from the beginning such research as might be needed to fill in certain gaps in our knowledge of the Indian tribes, from Vancouver as far south as the mouth of the Columbia River. The work of Gibbs, Boas, Eells, Willoughby and others had determined with considerable certainty the affiliations of the many tribes of this region, and in certain instances fairly complete information had been obtained regarding their customs, language, mythology, etc. There remained, however, a district on the west coast of Washington, from Cape Flattery to Grey's Harbor, of which little was known, and which promised valuable results upon investigation. It was consequently upon this region that the efforts of the expedition in Washington during the summer

of 1898 were concentrated, the work being intrusted to Mr. R. B. Dixon, of Harvard University, and the writer.

The stretch of coast-line mentioned is about one hundred miles in length, and inhabited only at a few points, where the Indians have formed villages at the mouths of streams. South of Cape Flattery, which with its immediate vicinity is included in the Makah Reservation, the Indians of that coast are of two tribes—the Quilleute and the Quinault. The Quilleutes are the more northerly, occupying two villages; the larger, known as Lapush, at the mouth of the Quilleute River, about thirty miles south of Cape Flattery, contains all the members of the tribe except a few families who live at Hoh, a cluster of houses some fifteen miles farther south. South of Hoh the coast is uninhabited for about fifteen miles, as far as Queets, the more northerly of the Quinault villages, which contains but a few individuals; while twelve miles farther down the coast, at the mouth of the Quinault River, is the main seat of the tribe, known by the whites as Granville, which is a sub-agency of the Indian Department, with a resident agent and post-trader. The climate of this region is mild throughout the year, but with an extremely high rainfall from October to June. Being freed from the hardships of the severe winters of the interior, these coast Indians find it a comparatively easy matter to procure the necessities of life at all seasons. The waters teem with salmon and other fish; shell-fish are abundant and much used; seal are hunted in the late spring, particularly by the Quilleutes, whose situation is more favorable for that purpose; and in the woods, which extend down to the beach at all points, deer, elk, black bear, and many varieties of small game, are abundant. The staple foods, however, of both tribes mentioned, are salmon (which are caught in great numbers with large nets,

dip-nets, and spears) and berries, gathered at the proper seasons and dried. Of late years, with the development of the salmon-canning and hop-growing industries in the regions about Puget Sound and the Fraser River, the life of these Indians has undergone a decided modification, due to the annual exodus of all able-bodied members of the tribes to secure work in the canneries and hop-fields. Employment is given to women, and even to children, and in prosperous seasons very considerable sums are earned by families, which money is, however, as a rule, promptly and not wisely spent at the nearest shop or trader's; and the Indians return to their homes in the autumn with little to show for their three or four months' labor except the experience, largely social, which is, after all, probably the great inducement which draws them to the work.

This absence of the Indians from their villages was the greatest obstacle to the work of the expedition in these two tribes.

Upon arriving at Lapush, about July 1st, it was found that the Quilleutes had gone in a body to the Fraser River for the fisheries, leaving behind a few men too ill to be carried, and enough women to look after their needs. Some days were spent in obtaining such linguistic information as was possible with the scanty material to work upon, and then, reports from the Quinaults being more favorable, the expedition proceeded to Granville, where some thirty individuals were found, the remainder having also gone to the Fraser River. The prospects being better at this point, it was decided to settle down and begin work. Measurements, casts, and photographs were obtained, as well as a mass of information regarding the language, customs, traditions, etc., of the people. As it was desirable to collect as large a series as possible of measurements and casts, it was decided early in August that Mr. Dixon should proceed to

the Fraser River, and prosecute that work as well as might be under the rather unfavorable conditions presented. This he did with entire success, obtaining a very valuable series of casts and measurements, as well as notes on the languages of both the Quilleutes and Quinaults, and later visited the Lillooet Indians in British Columbia before returning East.

The writer remained at Granville for some weeks longer, making researches and collecting ethnological material for the American Museum of Natural History, and about September 1st returned to Lapush to meet certain of the Quilleutes who had returned, and obtain further information regarding that tribe. The members of the expedition returned to New York about Oct. 1st.

Of the results of the summer's work, aside from the collections made for the Museum, may be mentioned as of particular importance the casts, photographs, and measurements for a systematic study of the physical anthropology of the tribes; the linguistic material, which proves beyond question the stock affiliations of both groups, the Quilleutes being shown to be of Chemakum origin (the true Chemakum tribe, which formerly had its seat near Port Townsend, being now extinct), while the Quinaults are of the extensive Salish stock which occupies nearly all of the territory about Puget Sound, and sends this offshoot north along the coast. The traditions of the tribes, of which full collections were made, are extremely interesting, exhibiting the characteristics of the traditions of the northwest coast in general, and showing particular affiliations with the immediately adjoining tribes. A great many of the stories are identical in every detail in the two tribes, except for slight changes of name, although the tribes are of totally distinct stocks, and the language of each is unintelligible to the other. The well-known myth of the 'transformer' is found well developed

in both instances, and the tales of the Raven as culture hero and trickster, so well known among the Indians farther north, are heard here among the Quilleutes, while the same adventures are told of Blue Jay among the Quinaults, as is the case among the Chinook and other neighboring peoples in the south. These traditions will form an excellent basis for a comparative study of the mythology of the region.

Particularly valuable information in regard to the conventional development of design in basket ornamentation was obtained among the Quinaults, bearing out the theory that the common geometrical figures which are used so much are almost invariably conventionalized representations of natural objects, and, as a rule, of animals. Notes on the social life and beliefs of the Indians were also secured, and observations made on the influence of the so-called 'Shaker' religion, which has been gaining a strong hold on the natives of that section during the last half-dozen years. In general it is hoped that the work of the summer will contribute very materially to the solution of many of the problems, general and special, which are offered by the Indians of the Northwest.

LIVINGSTON FARRAND.

ARCHÆOLOGICAL INVESTIGATIONS ON THE NORTH PACIFIC COAST OF AMERICA.

THE archæological work conducted on the northwest coast of America, prior to the organization of the Jesup North Pacific Expedition, was not extensive. The available knowledge concerning it is largely confined to three publications—two by Dr. William H. Dall, on cave and shell-heap remains of the Aleutian Islands; and one by Mr. Charles Hill-Tout, a *résumé* of the archæology of the southwestern portion of British Columbia.

The archæological investigations which I carried on in connection with the Jesup

Expedition during the past two years dealt chiefly with two problems: (1) examining the archæology of the southern interior of British Columbia; and (2) investigating the shell-heaps of the coast of Vancouver Island, together with those of the adjacent mainland.

In the southern interior of British Columbia, more particularly in the valleys of the Thompson and Fraser Rivers, now live tribes of the Salish Indians. This region is one of almost desert dryness. The houses of the Indians are covered with a roof of timbers and earth, and are partly underground. Unlike the tribes of the coast, who have such an abundance of the few staples—cedar, seal, salmon, and shell-fish—that they depend almost exclusively upon them, these people have to resort to a great variety of natural resources. Primarily among them may be mentioned the deer, which furnish them with skins for clothing, flesh for food, and bone and antler for implements. The sagebrush-bark is used for textile fabrics. Salmon are taken for food in the rivers, and berries and roots are obtained in the mountain valleys. Many objects are made of stone. They bury their dead in little cemeteries along the river, although an isolated grave is sometimes seen. Their method of burial in the ground, instead of in boxes deposited in trees, in caves, or on the ground, the conical form of their lodges, and their extensive use of chipped points of stone rather than of those ground out of stone, bone, and antler, ally their culture with that of the tribes of the East, and differentiate it from that of the coast people. None of the native peoples of British Columbia make pottery, and no pottery has been found by archæological work. Food was boiled by dropping hot stones into baskets or boxes containing it.

The archæological remains are found in the light sand of the valleys and hillsides. The wind is continually shifting this dry

sand from place to place. For this reason no definite age can be assigned to the specimens secured. It is certain, judging from the complete absence of European objects at many of the localities explored, that the remains found at these places antedate contact with the whites. A number of them must carry us back several hundred years. The modern Indians make small arrow-points, and disclaim the large kind found in excavations. The work undoubtedly proves that these ancient people and those now inhabiting this region were practically the same.

Numerous circular depressions were found, indicating the sites of ancient underground houses. The dry climate, and the action of copper salts, preserved bits of skin garments. Portions of the clothing, and bags that were made of the bark of the sagebrush, remain in the driest places. Beaver-teeth dice, exactly like those used by the present Indians; digging-stick handles made of antler, similar to those in use to-day; charred berries; fish-bones; and skin scrapers made of stone—were unearthed.

The graves were found in groups and also singly, as is the case with the modern ones. The bodies were buried upon the side, with the knees drawn up to the chest. They were wrapped in a fabric made of sagebrush-bark, and were covered with mats of woven rushes. Over the forehead and around the neck were strings of beads, some of copper, others of dentalium-shell. At the side, in a pouch also made of woven sagebrush-bark, were usually found such objects as pieces of glassy basalt, points chipped out of the same material for arrows and knives, a pair of grooved stones which were used for smoothing and straightening arrow-shafts, a set of beaver-teeth dice, bone awls and needles, quantities of red ochre, copper-stained clay and yellow earth used for paint.

The beads of dentalium-shell from the Pacific coast probably indicate intertribal trade. A number of war-clubs and several small animal figures carved in bone were found. The handles of the clubs were artistically sculptured to represent human heads with plumed head-dresses. Such specimens show that the ancient people were capable of a high order of artistic carving, which, perhaps, more than any of their other work, resembles the products of the coast culture. Stones burned and crackled, evidently by basket or box boiling, are found at all the village-sites and shell-heaps explored in British Columbia.

Several specimens, such as the stone mortar and the tubular pipe, remind us of the types found in Oregon and California. Ethnological investigations have shown the affiliation of the recent culture of this region to that of the Rocky Mountain region. These archæological evidences suggest that this similarity was even greater in the past.

Turning to the problem of the shell-heaps of the coast, it is necessary to note that the present tribes of the coast of British Columbia build immense houses of cedar planks. They depend largely upon the cedar and other wood for their implements and utensils. The bark of the cedar is made into garments, bags, mats, and the like; in fact, the cedar is to these people what the bamboo is to the Japanese. They rely greatly upon salmon and shell-fish for food. The seal also furnishes them with food and material for manufactures. They have developed an exceedingly high art in carving and painting, which is quite characteristic for the North Pacific coast.

The most extensive remains of the early inhabitants of the coast are shell-heaps. Their general distribution may be judged by the fact that in the region, less than a hundred miles square, on the shore of the north end of Vancouver Island, and the

mainland opposite, over a hundred and fifty were noted. In general they are located at the mouths of fresh-water streams, and are several hundred yards in length by five or six feet in depth, while a few are miles in length, and some reach a maximum depth of over nine feet. The presence of stumps over five feet in diameter standing on nine feet of these layers, of which but few are more than an inch or two in thickness, indicates a considerable antiquity for the lower layers. These are composed almost exclusively of the well preserved shells of clams and mussels, scattered among which are found a very few points and barbs rubbed out of bone, such as were used recently for harpoons, and bone-choppers for preparing cedar-bark, exactly like the implements used to-day in the manufacture of cedar-bark, mats, and clothing. Numerous stone pebbles with battered ends, such as are still used in a game resembling quoits, and a copper ornament in shape like those made of iron and now worn in southern Alaska, were also found in the heaps. One pair of these ornaments, made of copper, was found in a grave in the interior. The extreme scarcity of archaeological specimens in the very extensive shell-heaps of northern Vancouver Island is what we might expect if the early people depended as largely as do the present natives upon cedar products easily disintegrated by the warm, moist climate. The scarcity of human remains in the shell-heaps may be accounted for on the supposition that tree-burial, where the bodies fall and are soon destroyed or the bones scattered, was as extensively employed in former times as at present. Everything which has been found tends to prove that the ancient people who discarded the shells forming these immense heaps, over successive layers of which forest trees have grown to a diameter of four or five feet, were in all essential particulars similar in their culture

to the tribes at present inhabiting the same areas.

The shell-heaps in the delta of the Fraser River, while in general resembling those of the coast, present several marked differences. There is much more black soil, charcoal, and ashes among the layers of the shell-heaps here than in those along the beaches of the sea. The shells are much more decayed, and mixed with the black soil. Among the layers are found numerous skeletons of two distinct types of men; and the proportions of specimens to the extent of the shell-heaps is vastly greater than in the other localities, the specimens in the coast shell-heaps being much separated by vast amounts of shell material. Whether these differences are peculiar to the lower Fraser River, or are common to all fresh-water streams of the region, is problematical; and their cause, whether due to a change in the customs of the people, or to a variation in the people by mixture or succession, is worthy of study.

The age of these heaps is considerable. A stump of the Douglas fir over six feet in diameter stood on one of the heaps where the layers, there reaching a depth of over eight feet, contained human remains. This tree indicates an age, for the top layers, of more than five hundred years; and allowing for the formation of eight feet of strata of shell, ash, and earth, most of which are but a few inches in thickness, it must be conceded that the bottom layers are much older than this rather conservative estimate for the minimum age of the top layers. The annual rings upon an ordinary stump standing upon this shell-heap numbered over four hundred. The circumference of another stump exceeded twenty-eight feet.

The shell-heap at Port Hammond, in the upper part of the Fraser delta, is over twenty miles by water from the present seashore, where the shell-fish are found. By land, the nearest point of seashore is over ten miles.

Judging from the customs of the present natives, the water route would be used. But they prefer to live near the shell-beds. It is hard to believe that any of them would carry shell-fish from the present seashore to the shell-heaps at Port Hammond. The distance that the delta is built out into the sea, and the time required for this deposition, may furnish us some information as to the age of the Port Hammond shell-heaps.

There is no apparent difference in the character of the specimens found in the recent and in the older layers. The general style of the objects is similar to those made by the present tribes of the coast. Several exquisite specimens of stone and bone carvings were discovered, which rival in artistic merit the best sculpture of the existing natives.

Two types of skeletons were found which belonged apparently to coexistent people, as they were excavated from the same layers. If one of these types consisted of captives or slaves, there was nothing in the manner of burial to indicate it. Probably one type succeeded the other in occupation of the area. The fact that bodies were found in shell-heaps indicates that the customs of this people must have differed from those of the people who formed the shell-heaps on northern Vancouver Island, or that the former people was subjected to other influence.

The skeletons found were deposited at the time of the layers, and were not intrusive burials, as was clearly shown by the numerous unbroken strata extending over them. The bodies were usually lying upon the side, with the knees close to the chest. Unlike the skeletons in the interior, these have but few, if any, objects accompanying them, except, in rare instances, a few shell beads, copper objects, and chipped and ground stone points for arrows, spears, etc. Such specimens, and even more interesting objects, were frequently found in the layers.

There has been an apparent movement in prehistoric times of the Salish of the upper Fraser toward the coast. The skulls found in the old shell-heaps of the delta differ from those of the present coast Salish. The modern coast Salish has a skull apparently modified from this by admixture since coming to the coast. This is only additional evidence to what has already been suggested by linguistic research. A movement of such importance, and its attendant influences, may account for certain changes in ethnological customs, such as the rapid modification of the method of burial on the southeastern part of Vancouver Island. The earliest known kind of burial, and the one that is known to have antedated contact with the whites by a considerable period, was in stone cairns. Later, and even since contact with the whites, the bodies were placed in wooden chests, which were deposited on platforms in the branches of trees. This method was changed to depositing the boxes in caves or on little islands. In such cases a canoe was sometimes used instead of a box. Now, under missionary influence and legal restraint, these people bury as do the whites of the region.

The cairns come within the field of archaeological investigation. They consist of irregular piles of boulders, from twelve to twenty feet in diameter, thrown over the body, which was placed in the usual flexed position. In most cases it was surrounded by a rectangular vault formed by placing the straight sides of four or five boulders toward the body, and covering the cyst thus made with one or two slab-shaped rocks. Over this the rough pile of the cairn would be reared. A few copper ornaments have been found buried in cairns. The skeletons are usually much decayed, and complete skulls from the cairns are rarely obtained. In excavating twenty-one cairns in 1897 no entire bones were secured. In

1898, however, we met with better success, obtaining a number of complete skeletons.

Several burial-mounds were formerly located along the lower Fraser River, between Hatzic and Port Hammond. The remains in them are usually much decayed, and but little is known about them. The one which we found intact was explored by us, and its contents were seen to be much decayed.

It remains to find material upon which to reconstruct a knowledge of the builders of the burial-mounds of the lower Fraser River. The map showing the distribution of cairns should be completed. The marked difference between the shell-heaps explored along the salt water, and those investigated in the delta of the Fraser River, demands that inquiry be continued to determine whether this difference is correlated to salt- and fresh-water shell-heaps, to heaps of certain geographical areas, or is due to change in customs. The determination of the distribution of shell-heaps of both varieties is also necessary. Many of the specimens discovered in this work are known to be of considerable antiquity, and, on the whole, the culture shown by the archæological finds is similar to that of the present Indians. It is consequently known that this culture has continued practically unchanged during recent times. This being settled, it is desirable to learn of its development, for which it is imperative to search out older deposits. These may possibly be found in shell-heaps, under cave-floors, or in post-glacial gravels.

HARLAN I. SMITH.

AMERICAN MUSEUM OF
NATURAL HISTORY, NEW YORK.

ARCHÆOLOGICAL INVESTIGATIONS ON THE AMOOH RIVER.

THE Amoor River, below Khabarovsk, flows through a succession of former lakes and the rocky barriers which separated

them. There are extensive level tracts, the bottoms of drained lakes alternating with passes between hills or mountains. Nearly all the flats are subject to overflow. They are covered with coarse grass from four to seven feet high, and intersected in all directions by sloughs and bayous. At no point is the river less than a mile wide; in floods there are many places where no land is visible for ten miles or more; and at one locality it is fully twenty miles across. At such times the current in some parts of the channel flows from twelve to fifteen miles an hour. The shores are free from silt or mud. One may walk for miles on the beach, immediately after a heavy rain, without soiling his shoes. An important result of this, to primitive people, is that shell-fish are almost entirely lacking. A few periwinkles and occasionally a mussel are found, but there is not the slightest evidence that such were ever used as food. The water seems comparatively free from lime.

There is no flint from which arrow- or spear-heads could be made, and very little stone, except bowlders and pebbles on the shores, suitable for the manufacture of axes. None of the former, and very few of the latter, were found. Wood, bone and antler seem to have been about the only material for weapons and implements.

The winters are long and severe. A temperature of 67° below zero (Fahr.) has been recorded at Nikolaievsk, and a skim of ice was formed there in August (1898).

There are no roads. Navigation is possible for only four months, sledge travel on the river, another four, while for two months in spring and two in autumn all travel is suspended.

The hills are steep, rugged, and covered with fallen timber, brush and vines. Only hunters and prospectors ever go among them. In most places primitive wilderness is reached within a few hundred yards of

the stream. Short journeys may be made on the beach, but one soon comes to the outlet of a lake or swamp which cannot be crossed.

Settlements are confined entirely to the banks of the river, at points where there is good landing for canoes. Most native villages, and some belonging to the Russians, are subject to overflow. There are very few high terraces bordered by a good beach. On a rocky shore, canoes would soon be dashed to pieces by waves, which in severe storms attain a height of five or six feet.

Above the mouth of the Garoon River dwells the native tribe of Gold or Goldi. Below Sophisk, extending along the coast to Okhotsk Sea and Saghalien Island, are the Gilyaks. The intermediate territory is occupied by both tribes. At present they obtain guns and knives from the Russians; formerly they had only such hunting or fishing material as they could make for themselves or get from the Manchu traders.

In summer the elks come down from the mountains to feed on the lilies and grasses in the marshes. The Gilyak hunter secretes himself and patiently waits for his quarry to come within easy range. In winter they go, either singly or in a party, into the mountains to hunt fur-bearing animals. The sable is the chief animal sought, as a good skin is easily exchanged for its weight in silver, and a fine one brings much more. Sometimes they spend the entire winter at the camp, though it may be only a few miles from home.

At their summer camps they make huts of birch-bark. Sometimes there is constructed a framework of posts, cross-poles, and rafters, on which the bark is fastened by tough, twisted vines, the roof being held down by poles and stones. Again, they tie a bundle of poles together at the top, and spread the bottoms as far as they wish. This framework is covered with bark (or sometimes with skins, and nowadays pos-

sibly with tent-cloth), in the fashion of an Indian wigwam. A fire is made in the middle of the floor; blocks of wood, or short forks driven into the ground, support poles, brush, and grass for seats and beds.

Winter dwellings are more elaborate. A space is marked out from twenty to fifty feet square, the size depending upon the number of persons to be housed. The earth is excavated within these lines, the depth of the excavation being governed somewhat by the character of the soil. It is usually between two and three feet. Posts are set around the edge of this, on which a wattle is constructed; mud is thickly plastered on both sides. The roof is made of poles and heavily covered with mud. Earth is also piled up around the base of the house to a height of three or four feet. A fireplace or furnace is made of stones in one corner. A large kettle is set into the top of this, and every crevice chinked with mud. From the fireplace, flues extend around the sides of the room, made of flat stones set on edge and covered with others. There may be two, three, or four of these flues, side by side. If flat stones cannot be had, others are used, the interstices being chinked. In large houses two furnaces are made in opposite corners. All the flues unite finally into one, which is carried through the wall and to a chimney from fifteen to twenty-five feet away, on the outside. This may be a hollow trunk or may be made of boards. It furnishes sufficient draught in any weather. Over all the flues are piled sand and fine gravel, confined at the front by boards, and carefully levelled on the top. The 'bench' thus formed is sometimes six feet wide. The inmates literally live on it when in the house. It is always warm and dry when the fires are going.

A careful and methodical investigation was made along the river for three hundred and fifty miles above its mouth, and of the

coast along the Channel of Tartary as far as Okhotsk Sea. No evidence whatever could be found to indicate a former population different from the present. The swift current and high waves keep the gravel and sand of the beach continually shifting. It was possibly for this reason that so little was found on the shores. Not a worked flint was seen. There were hundreds of fragments of pottery, about thirty polished stone hatchets or scrapers, some notched sinkers and a few other stones, showing marks of use or attempts at shaping. Above the water-line, grass and weeds grow so abundantly that the ground is hidden. In the few places, where vertical exposures of the banks occurred, every foot was carefully examined; but there was not a fragment of pottery, a piece of charcoal, or any other evidence of human occupation, to be seen below the sod. This is true of all terraces, whether subject to overflow or not. The natives say the 'old people' (meaning thereby their predecessors, without regard to time) used the polished stone implements. Now better utensils can be had from the Russians. Most of the pottery is Manchurian, as is proved by its marking or decoration. The remains of a Chinese town may be seen in the woods at Tyr; three inscribed monuments formerly stood near here. The inscriptions have been deciphered, and prove to be Manchurian.

There are no shell-heaps, of course, because no shells; no mounds; no stone graves; no graves, except modern ones, with any mark to show their existence.

When a Gilyak house is abandoned, it soon goes to decay. The earth piled around the base is increased in amount by that falling upon it from the walls, and when the wood all decays there is left an embankment surrounding a depression. If the roof-timbers hold for a year or two, the earth is washed off and adds to the em-

bankment; if this dirt falls directly downward, it lessens the depth of the depression.

In the entire region examined, these abandoned house-pits was found. In some, part of the timbers were still in their proper position. In others the timbers were all more or less decayed. In still others no trace of wood remained. Step by step could be traced the gradation from the house just deserted to the house-pit covered with moss and turf to an equal thickness with that on every side, and overgrown with pine trees up to thirty inches in diameter—as large as any observed along the river. All are constructed in the same way, and several which were trenched across showed the stone flues just as they are made at present.

There may be ancient remains here yet to be discovered; but so far none have been found which may not be properly attributed to the present native tribes, or to the Manchurians, who until recently owned this territory.

GERARD FOWKE.

ON BIOLOGICAL TEXT-BOOKS AND TEACHERS

A GENERAL indictment against text books may be drawn, to the effect that, like the teachers who are usually their authors, they proceed on the assumption that all who pass through their sphere of influence are to become specialists in that particular department of knowledge. This tendency carries its own *reductio ad absurdum* and is the cause of frequent revolutions in 'methods of teaching.' A new phase of the subject, a new standpoint from which to present it, is at first tentatively added or partially substituted for the old course of study, with noticeably excellent results. Not realizing that the improvement is secured by the introduction of moderation, balance and sanity into the work of instruction, the inference is at once drawn that still more startling effects are possible through further progress in the direction whence the light

came. Very soon, however, the mean is passed, the new has become the old, the simple the complex, and another advance, return, or deflection, is in order.

The history of biological instruction in schools furnishes a good illustration of these phenomena. The systematists had the first botanical opportunity, which they proceeded to abuse. Not content with the original practice of giving beginners a slight acquaintance with the names and properties of the more prominent local plants, they arranged for the laying of broader foundations for systematic work; manuals containing thousands of species and requiring extended experience for their profitable use were put into the hands of academic pupils prepared only by a brief course in definitions. The vital activities of plants went unnoticed; they were not organisms to be understood, but objects to be named. Such a one-sided and sterile method could not be perpetuated in the treatment of a subject having any practical bearings, and the necessary revolt followed. Numberless facts of internal structure and organic functions, problems in physics, chemistry and electricity were then brought to light and put before the budding mind as containing the essence of botany, and now the extreme of development in this direction is being reached.

That the training of specialists is not the primary object of instruction in biology, in primary and secondary schools, or even in the college, will be admitted by all. The available time is limited, more commonly painfully short. The interest of pupils is necessarily divided and fragmentary on account of the numerous subjects they are obliged to follow simultaneously; originality and the power of clear insight are in process of destruction by a continuous surfeit of educational provender. Biology cannot hope to monopolize time or attention, and hence the first problem of instruction is

to employ the meager opportunities to the greatest good of the student. The course which will obtain the maximum of pleasurable interest is also that which will produce the most lasting and satisfactory results. The teacher is the mentor and guide in the fields of knowledge. If he were in charge of a party of his pupils who were visiting England, and had a week to see London, the systematist would advise that six days be spent with the maps and guide books, so that his students might be able to call the principal buildings and streets by name while driving to Westminster on Sunday; the laboratory instructor would consistently employ the week at the Tower, mostly in careful examination of the foundations. Both suggestions would have advantages if the visitors were to remain in London six months or a year, but with the sojourn limited to a week the young people would in each case come back 'disappointed at not having seen the city, and this may properly be the state of mind of thousands of students of biology and its departments. They have a right to see as many and learn as much about living creatures as time and opportunity will permit; to proceed as though they were to spend a lifetime in pursuit of some biologic speciality' is a piece of criminal stupidity not unfrequently alloyed with a considerable amount of laziness, since both the extreme methods are reducible to a definite class-room or laboratory routine capable of comparatively easy management, while to maintain a well-balanced middle course, giving a maximum of knowledge in logical and orderly arrangement, requires alert and sympathetic comprehension, both of facts and of persons.

But of what should general tuition in biological subjects consist? The answer must vary with the pupils, the facilities and the time. To specify any method, standpoint or sequence as the unqualified 'best' is to lose sight of the differences and

limitations which must be considered in particular cases. There are, however, some simple and universal demands which all general courses in biological subjects may be expected to meet, but which are frequently neglected in favor of the special instruction deprecated above.

1. *Formal instruction should not fall behind general knowledge in dealing with familiar things.* This does not mean that students of zoology should all become veterinarians, but it does mean that they should know something more about horses than the average of uninstructed humanity. It is no special credit to the educated man who 'had a course in botany' to be badly poisoned by contact with a weed which thousands who never heard of botany have learned to avoid. To be able to recognize the more common edible fungi is an accomplishment which none would be likely to regret. In fine, the educated man is a man none the less, and a part of nature throughout his mortal life, and any so-called instruction which does not, within its particular province, increase his efficiency in contact with his environment lacks prime elements of interest and importance.

2. *Literary development requires the command of a reasonable scientific vocabulary.* It is too late in the age of the world for whales and porpoises to be called 'fish,' for corals to be called 'insects,' for lichens to be called 'moss.' For literary purposes, if for no other, a man should know an elm from a hickory or a woodbine. The ignoramus is no longer at a premium on account of any supposed profundity. The poet who has his crows' nest in the fence corner will surely come to grief and derision, likewise he who puts the swallows' nest in the tree.

3. *To insure familiarity and subsequent recognition, natural objects should, as far as possible, be seen in nature.* The graduate from school or college who has not gained a larger insight and a deeper interest in surrounding

nature and natural objects may know, without peradventure, that he has suffered a grievous loss through the incompetence of the biological contingent of the faculty. The teacher who is accustomed to carry his classes 'through' botany and zoology without taking them into the field is a dangerous fraud whose 'course' consists in some routine work or specialized sawdust which the general student can safely neglect as likely to be of minimum utility or bearing on culture.

4. *Every science should give its students a general view of its subject-matter.* At some time in the course of their biological education students should see and examine, if possible, representatives of the principal groups of animals and plants. It may or may not be desirable to go into great detail in the study of these 'types,' certainly not if thereby the other numbers of this enumeration are to be neglected. It is far better to show the general student forty different sorts of crustaceans and point out their general agreement in structure than to have him spend the time in cutting up one particular form and in learning the names of parts and organs which he never saw before and will never see again.

In the botanical text-books used in the secondary schools ten years ago only the barest mention of the lower plants was made, ferns, mosses, fungi and sea-weeds being summarily dismissed as 'Cryptogams.' In a recently published work of secondary grade the structure, organs and functions of mosses, for instance, are explained or discussed in nine different places. It is safe to say that the information furnished in this form serves to obscure already confused ideas of physiology and morphology rather than to widen and clarify the student's botanical horizon by giving him a modicum of elementary knowledge concerning an interesting group of organisms.

5. *Every science should give its students an*

introductory acquaintance with its methods of investigation. How has the science been built up? What extent of work has been accomplished and what remains to be done? What important problems are now receiving attention, and how is the work being carried on? What are the possible bearings on utility or culture of such investigations? These and numerous others are legitimate and pertinent questions being constantly asked by those inside as well as outside of scientific lines. Under this head it is desirable to make a careful dissection and thorough microscopic examination of at least one animal or plant. It is something to know how an eclipse is calculated or how a plant is 'analyzed,' even if we never attempt either feat after having 'passed up.' Together with a reasonably thorough investigation of the structure of some one form, the student should collect and learn to know the local flora or fauna in some natural group, even though a very small one. Instead of manuals of extensive regions, school purposes would be far better served by carefully written local monographs which could be made really adequate for purposes of determination in the hands of the inexperienced. By being less formidable such works need not be less scientific. Greater simplicity would also make easier the comprehension of the principles of classification and the meanings of its various categories. Repetitions and demonstrations of interesting or famous experiments are also valuable, but to confine a class in the laboratory and hurry it through a long series of such may result merely in intellectual nausea on the part of the victims.

These limited specializations are desirable as part of every general course, but the field or the problem should in each case be so narrowed that the student may reasonably be expected to gain some insight in the time available. To say that all work must be experimental or all histological or all

systematic is merely to commit the same mistake in three different ways. Biology has an advantage over many parts of school curricula in that its subject-matter contains much of daily interest and permanent value. Although other departments commonly justify their existence by appeal to the fallacy that mental training can be successfully divorced from instruction, biology has less need of such an admission. The gymnasium may be theoretically the best place to secure symmetrical muscular development, but the stronger attraction is exerted by foot-ball or boat-racing, and college faculties have themselves largely to thank for the fact that these subjects monopolize so extensively the attention of undergraduates. The growing mind demands some object of tangible, contemporary, individual interest, and if this is not found in the curriculum it will be sought outside. A knowledge of foot-ball relieves many a college graduate from the charge of being a complete ignoramus. Interest in nature for its own sake is, however, also a normal and very common characteristic of younger individuals of the human species, and while the routine of school life tends to an early eradication of this quality, its extinction is seldom complete, and the competent teacher knows how to utilize it as a most pleasant and important adjunct to the work of instruction. The popularity of the weekly excursion of classes in botany and zoology has even caused resignations from the foot-ball team.

While the training of specialists is not the object of any schools except the universities, the importance of investigators in modern civilization is too great to justify the neglect of the interests of such during the educational period. Investigators, however, of all others, need to acquire this more popular and more general knowledge of their own specialty. To be drilled from their earliest days only in methods of in-

vestigation, either systematic, structural or physiological, is to destroy originality and keep narrow the ground on which future generalizations must be built. It is accordingly plain that to limit a student's opportunities for biological instruction to a specialized course along some one line has not even the single justification it at first seemed to possess. The present extreme tendency toward 'laboratory work' and away from actual contact with nature on the part of beginners in biology is without doubt a temporary condition. Not every one who sits behind a battery of reagents in a laboratory is an investigator, and not all investigators are thus equipped.

At the cost of an equal amount of labor, which would command the general preference, an acquaintance with the more common plants of one's neighborhood or a mass of facts about plants in general, but applicable as a whole to no plant in particular? Organs, tissues and functions have been named and classified; knowledge in these directions is becoming extensive and complex, and the specialists are zealously trying to keep the beginners up with the times. Recent text-books written from structural and physiological standpoints contain a mass of definitions and an amount of classification equalling or exceeding that of the other extreme in systematic works. This classification is, indeed, not what prominently bears that name, but it is classification none the less, though artificial and based on abstractions instead of affinity or phylogeny. The details of structure and life history are arranged under such heads as 'Growth,' 'Reproduction,' 'Nutrition,' 'Irritability' and 'Symbiosis,' and the emphasis is not upon the facts in nature, but upon the mechanical or chemical considerations which must be invoked to explain the various special problems.

A complaint has been voiced that these so-called modern methods of instruction are

atal to the interest and spirit which actuated the naturalists of former days, and this is not difficult to understand. Such work is preparatory only for chemists, physicists and physiologists. Its interest is not in nature, primarily, but in matter and mechanisms. Under the extreme systematic method we had introductions to plants of which we knew nothing; by the avowedly unsystematic method we learn facts about plants which we do not know.

O. F. COOK.

U. S. NATIONAL MUSEUM,
WASHINGTON, D. C.

SCIENTIFIC BOOKS.

Text-Book of General Physics for the Use of Colleges and Scientific Schools. By CHARLES S. HASTINGS, PH.D., and FREDERICK E. BEACH, PH.D., of Yale University. Boston, U. S. A., Ginn & Co.

Apart from the obvious distinction between good and bad, text-books in Physics may be divided into two well-marked classes. In the one the main point of view is to consider the study of Physics as a training of the mind; as a subject which requires the use of logical processes and which ought to develop mental accuracy and habits of thought better than any other science.

The other class of text-books does not lay so much stress upon logical methods, but calls attention rather to the phenomena of Nature which are illustrations of the great fundamental laws, and to the experimental methods by which these laws have been discovered.

The continued success of such text-books as those of Ganot and Deschanel shows that there is a great need in American colleges and schools for the class of text-book which comes under the second head, just mentioned. The most recent text-book, this by Hastings and Beach, is distinctly one of the same order. It treats the subject, however, in a thoroughly modern manner and is free from the inaccuracies of the earlier treatises. One's first impression on opening the book is of great satisfaction. The paper, type, illustrations, arrangement of matter, everything which per-

tains to the printer's art, is more satisfactory than perhaps in any modern text-book of science, and the more one investigates the book itself the more one is convinced that the authors have successfully accomplished their purposes.

The subject-matter is arranged in the following order: Mechanics, Heat, Electricity, Sound and Light. The scope of the book is rather wider than would allow its use in most colleges or schools, including, as it does, such points as radius of gyration, compound pendulums, Carnot's cycle, Thomson and Joule's experiment, entropy, virial, osmotic pressure, thermo-electricity, theory of alternating currents, impedance and so on, electric waves, efficiency of optical instruments, theories of color sensation, and wave surfaces of uniaxial and biaxial crystals. A knowledge of trigonometry and the elements of analytical geometry are presupposed for the study of the book, but no previous knowledge of physics is expected.

Each of the main subjects of Physics is discussed with considerable fulness and is illustrated by many natural phenomena and by many mechanisms and devices in common use. This is particularly true in the subjects of Mechanics and Electricity. One knows before one looks that there will be a most satisfactory explanation and discussion of optical instruments. In fact, all the chapters on Light are of marked excellence.

It should be particularly noted that special attention is paid throughout the book to the description of the various instruments used in physical measurements. The chapters on music, musical instruments and color-sensation are admirable. The book closes with an excellent index.

One may think that occasionally there is want of balance in the amount of space given various subjects and in the arrangement of these subjects. For instance, the space given the 'conservation of momentum' is only about half a page, whereas that given the centrifugal drier and the centrifugal cream separator amounts to nearly four pages. The discussion of measurement of matter and of the concept of force is most briefly stated. It may be said, however, that in a text-book of

this character, where the purpose is not to acquaint students with the fundamental principles of Physics and with their logical development, but rather to give them a knowledge extending over wide fields of the phenomena of Nature and to correlate these in groups, such criticism as this is not applicable.

If one speaks of certain questions which do not seem to be treated as well as they might be, it is not from any wish to detract from the high merit of the book, but rather to call the attention of teachers who may use the book to certain points concerning which questions might be raised. In particular, it is doubtful if the chapter on Thermometry or on Calorimetry could be regarded as satisfactory by a class. It is hardly fair in defining a scale of temperature to use, as is done on page 165, the formula for the law of gases, and then to state, as is done on page 179, that "Experiment has shown that in the case of a gas under constant pressure not only is the expansion strictly proportional to the increase of temperature, but that all gases have sensibly the same coefficient." This seems to be using a quantity to define temperature and then to make use of the definition in stating a law.

Again, the words 'definite quantity of heat' are used in what may be considered an indefinite manner. On page 251 the authors use the following words: "The now universally adopted theory that heat is the kinetic energy due to the irregular motion of the molecules of a body"—a statement which is not altogether justifiable. It is possible to speak of the energy of a body and to consider it as partly kinetic and partly potential, using the latter name simply to include all energy that is not, strictly speaking, kinetic from our present knowledge; and it is possible also to say by way of definition that we will call the kinetic energy of the parts of the body by the name 'Heat.' This, however, is quite a different matter from saying that all the heat-effects are manifestations of kinetic energy, or from using the word 'Heat' in the sense of something that is 'applied' to a body, which is the sense most commonly used by the authors.

It is to be regretted that such phrases as 'molecular attractions of the particles of a solid

for those of a liquid are greater than the attractions——' p. 142; 'zinc has a greater affinity for oxygen than copper,' p. 386; 'the bond uniting the hydrogen to the acid radical SO_4 will be ruptured,' p. 388; 'an electrolyte capable of a reaction with one of the conductors,' p. 388, should be retained in a modern text-book. Exception must be taken also to the use of the word 'molecule' on p. 237 without any explanation; to the phrase 'mechanical equivalent at $15^\circ \text{C}.$,' on p. 264; to the explanation of what is meant by a 'reversible' cycle on p. 269; to the definition of the 'ampere;' to the use of the expression 'stationary waves;' and to the expression 'it is assumed that the current enters.'

Certain explanations are undoubtedly erroneous, such as those of electrolysis, scintillation and the theory of 'angle of contact' in capillarity; while others are not rigid or not definite, such as those of the simple pendulum, the barometer, Röntgen rays, iridescence.

There are several slight mistakes throughout the book, such as the incomplete statement of Döpler's principle, the use of R instead of R_0 in the two formulæ of Van't Hoff on pages 236 and 240, the statement on page 263 that there are discrepancies between the values of the mechanical equivalent as found by the two methods.

As a text-book of the character evidently planned by its authors this treatise must, however, be considered most successful. It is a book to which every student would have occasion to refer from time to time, and which contains within its covers much more matter than any existing book of its class. The style is pleasant, attractive and definite, and every laboratory and library would do well to purchase the book.

J. S. AMES.

JOHNS HOPKINS UNIVERSITY.

The Principles of Stratigraphical Geology. By J. E. MARR. Cambridge Natural Science Manuals, Geological Series. Cambridge, University Press; New York, The Macmillan Co. 1898. Pp. 304.

Here is a book on a single department of geological science which is the type of many

another. Written to give students some idea of the methods and scope of stratigraphical geology, it combines a digest of the contents of larger standard manuals, with an elaboration of some points according to the author's views, and requires for its full understanding a familiarity with structural and dynamical geology, the nomenclature of paleontology, and a minute acquaintance with the local nomenclature of English geography.

The omissions in the earlier chapters imply that the student is preparing for field work after having read Lyell's *Principles* and Geikie's or some other text-book, while the substance of the chapters reads like lectures given to a class of beginners.

The second half of the book is by far the more valuable, in that it gives a brief, but clear and well-written summary of the stratigraphy of Great Britain, with here and there references to the more conspicuous points of stratigraphical classification in other countries. The stratigraphy of England, Wales and Scotland is described with just enough detail to bring out the differences of sedimentation in separate regions for each period, and shows the growth of the island during geological time.

A fuller treatment of this element of stratigraphy is given in Jukes-Brown's 'Building of the British Isles.'

Some of the author's peculiarities are seen in his classification and use of terms.

Lapworth's term Ordovician is adopted. In his list of systems are included Permo-Carboniferous and Permian, in addition to the Carboniferous.

The grounds of this usage are 'primarily' the recognition of an unconformity between the Carboniferous and Permian in England; and secondly, the correlation of a portion of the Salt Range strata of India as intermediate between these two 'systems' of the English column.

In the Cenozoic six 'systems' are cited, viz: Eocene, Oligocene, Miocene, Pliocene, Pleistocene and Recent; but we are told in the text that these are hardly systems in the sense in which the term is used in the case of the older rocks. Further on, the chapters describing these formations are headed as follows: 'The Eocene Rocks,' 'Oligocene and Miocene

Periods,' 'Pliocene Beds,' 'Pleistocene Accumulations,' 'The Steppe Period,' etc.

The abysmal origin of the black shales of the Ordovician, with graptolites, is defended on the following grounds: The persistence of lithological characters over wide areas; their replacement by much greater thickness of normal sediments along ancient coast lines; the frequent occurrence together of blind trilobites and those with abnormally large eyes, and the interstratification of the black shales with radiolarian cherts similar to the modern abysmal radiolarian oozes.

The glacial origin of the boulder beds of the Talchin stage of the Indian series, proposed by W. T. Blanford, is accepted; and confirmatory evidence is cited in the cases of the similar signs of glaciation in beds of a corresponding age in Australia, South Africa and southern Brazil.

As a digest of the general facts of British geology in its special nomenclature the book will be of value to those who have not access to the fuller treatises.

HENRY S. WILLIAMS.

The Examination of Water (Chemical and Bacteriological). By WILLIAM P. MASON. New York, John Wiley & Sons. 1899. Pp. 135.

The progress that has been made during the last decade in methods of sanitary water analysis, and especially in the interpretation of the results of such analysis, amply justifies an attempt at the marshalling of the new data and the revaluation of the old. To both students and practical workers the need of a really modern treatise in the English language has become imperative, and Professor Mason's little book will, on this ground, be cordially received. It will be a fact regretted by many, however, that the present work is so limited in scope. While the author correctly insists upon the paramount importance of a complete knowledge of the source of a sample of water and of the conditions under which the sample is collected, and rightly emphasizes the futility of 'standards' of purity, he has evidently not intended to include in this book any discussion of some of the other and most vital problems of water analysis.

The various methods for the determination of

chlorine, nitrites, nitrates, free ammonia, albuminoid ammonia, etc., and the other significant chemical tests are described in the second chapter, and the author's selection of recommended methods will, on the whole, meet with general approval. The useful 'normal chlorine' maps, prepared respectively by the Massachusetts and Connecticut State Boards of Health, are reproduced and the hope is expressed that the task of the water-analyst will, in the future, be made still easier through the preparation of similar charts by other Commonwealths.

Some analysts will consider that more stress might have been profitably laid upon the Hehner method for the determination of 'permanent hardness,' especially in view of the fact that this method has been found greatly superior to the 'soap test' in dealing with the waters in some parts of the United States. In this chapter, too, it will occasion some surprise to find no reference whatever to the Kjeldahl method for determining organic nitrogen.

In the chapter upon bacteriological examination the author seems to be treading on less familiar ground than in the preceding section. In his description of the method of preparation of sugar bouillon the importance of the preliminary removal of muscle-sugar is overlooked, as is the fact that the indol test may be vitiated by the presence of muscle-sugar in the broth. Miquel's method of examination and his theory of 'auto-infection' of waters are given a much more important place than would be accorded them by most bacteriologists. The author's statement on p. 117 that 'great cold is not fatal to germ-life' certainly needs some revision.

EDWIN O. JORDAN.

A Monograph of the North American Potentilleae.

By PER AXEL RYDBERG. Memiors from the Department of Botany of Columbia University. Volume II. Issued November 25, 1898. 4to. Pp. 223. 112 plates.

Some years ago Dr. Per Axel Rydberg, a Scandinavian botanist educated in America, became interested in the group of the Rose Family which contains the *Cinquefoils*, and which have been known as the Potentilleae. Finding in the great collections of Columbia University (now transferred to the New York

Botanical Garden) a rich mass of materials, he set himself to the task of making a complete monograph of the tribe, accompanying it with such a collection of plates as would throw as much light as possible upon the limits of genera and species understood by him. After nearly two years of delay the volume has appeared, and it is all that the friends of the author anticipated, and more too. It is a beautifully printed quarto volume of 223 pages and one hundred and twelve finely executed plates.

In discussing the relationship of the tribe Dr. Rydberg regards it as representing the lowest or primitive type of the family Rosaceae, and from it arose, as separate, divergent groups, the tribes Dryadeae, Rubeae and Sanguisorbeae, while from the latter arose the Roseae (with possible relationship to the Dryadeae). On the other hand, from Dryadeae arose the Cercocarpae and Spireae, and from the latter are derived by divergent development the families Pomaceae, Drupaceae and Saxifragaceae. In regard to other relationships the author says: "It is evident that the Ranunculaceae and Rosaceae are very nearly related," and in his diagram showing the foregoing relationships places the Ranunculaceae immediately below the Potentilleae.

Thirteen genera are recognized in the Potentilleae, of which the largest is *Potentilla* with 107 species. The next in point of numbers is *Horkelia* with 47 species, followed by *Fragaria* with 20, and *Drymocallis* with 13. Quite naturally, the author found it necessary to describe many new species, and occasionally to give a new name to an old species, because of the preoccupation of the old name. He has been rather conservative in this part of his work, for which he deserves our thanks. In *Fragaria* the new species are as follows: *F. crinita*, *F. sibbaldifolia*, *F. truncata*, *F. platypetala*, *F. prolifica*, *F. pumila*, *F. terrae novae*, *F. pauciflora* and *F. firma*. In the much larger genus, *Potentilla*, there are but nine new species, but this is due to the fact that Dr. Rydberg, in his work upon this genus, published many new species a couple of years ago in the *Bulletin of the Torrey Botanical Club*.

A most interesting table closes the text, giving data as to the distribution of the Potentilleae in North America. From this we learn that in California there are 64 species, in the Rocky

Mountains 61, in Oregon and Washington 53, Saskatchewan Region 29, Canadian Rocky Mountains 28, Texas and Arizona 27, the Great Plains 26, New England and Middle States 26, Great Basin 23, British Columbia 22, southern Mexico 19, Labrador and Baffin's Bay 17, the Prairie Region 17, Canada 16, Alaska 16, Greenland 15, Arctic Coast 12, Southern States 8, northern Mexico 8, Lower California 7, Central America 2.

This monograph must at once become authoritative for this group of plants, and to every working botanist dealing with the higher seed-bearing plants it will be indispensable.

CHARLES E. BESSEY.

THE UNIVERSITY OF NEBRASKA.

SCIENTIFIC JOURNALS AND ARTICLES.

Terrestrial Magnetism and Atmospheric Electricity for March.—The promised series of portraits of eminent magneticians and electricians is begun in the present number with that of Professor Arthur W. Rücker, the President of the Permanent Committee on Terrestrial Magnetism and Atmospheric Electricity of the International Meteorological Conference. The journal has been enlarged to 72 pages, the present number being also freely illustrated and containing several important contributions by eminent investigators, as will appear from the table of contents:

Aimantation Induite par le Champ Terrestre sur les Aimants, E. Mascart.

Is there a 428-Day Period in Terrestrial Magnetism? J. F. Hayford.

Beobachtungen über die Eigenelectricität der Atmosphärischen Niederschläge, J. Elster and H. Geitel.

The Physical Decomposition of the Earth's Permanent Magnetic Field—No. 1. The Assumed Normal Magnetization and the Characteristics of the Resulting Residual Field, L. A. Bauer.

Is the Principal Source of the Secular Variation of the Earth's Magnetism within or without the Earth's Crust? L. A. Bauer.

Tafeln zur Genäherten Auswertung von Kugelfunctionen und ihren Differentialquotienten, Ad. Schmidt (Gotha).

Erdmagnetische Beobachtungen im Umanaks Fiord (Nordwest-Grönland), 1892-93, H. Stade.

Abstracts and Reviews.

Notes: Biographical Sketch of Professor Rücker. Activity in Magnetic Work.

SOCIETIES AND ACADEMIES.

THE SCIENTIFIC ALLIANCE OF NEW YORK.

A DINNER, arranged by the Scientific Alliance of New York, took place at the Hotel Savoy on the evening of April 5th. Mr. Cox presided and made an address emphasizing especially the need of bringing scientific work to the attention of those who are not special students of science. Other addresses were made by Professor Van Amringe, Professor Osborn and Mr. Leipziger, and these were followed by shorter speeches by Professor Dodge, Professor Cattell, Dr. McMurtrie, Professor Lloyd, Professor Dean, Professor Rees and Professor Hallock. At the conclusion Professor Britton, the Secretary, gave an account of the history of the Alliance in the following words:

The Scientific Alliance of New York was founded at a conference of delegates from the several societies held at the Museum of Natural History, March 11, 1891, pursuant to a suggestion made to the societies by the Council of the New York Academy of Sciences. These delegates were at first termed a Joint Commission, following the lead of the earlier established Alliance of the scientific bodies of the city of Washington. On May 19, 1891, a Constitution was adopted in which the term Council was first employed. At this time the issuing of an Annual Directory was provided for, and the first one printed was distributed in June of that year, containing the names and addresses of the 498 members of the Alliance comprised in the six original societies. The publication of the monthly Bulletin, announcing the titles of communications to be made to the societies and other matters of interest was authorized September 28, 1891. Both the Directory and the Bulletin have since been continued, with minor modifications, in the form thus inaugurated, eight numbers of the Directory and sixty-three numbers of the Bulletin having been published.

The New York Section of the American Chemical Society was admitted as a part of the Alliance in May, 1892. The second Annual Directory, issued in July of that year, shows that the membership was then 633; on November 15, 1892, the first joint meeting of the societies was held at the Museum of Natural His-

tory, and a number of addresses bearing on the progress and the needs of science in New York were delivered; these were subsequently printed in pamphlet form and widely distributed. At a meeting held November 25, 1892, a Finance Committee was appointed; this Committee secured by subscription a considerable sum of money, subsequently termed the General Fund of the Council, as distinguished from the sums annually contributed by the societies for the publication of the Directory and Bulletins, known as the Societies' Fund. The General Fund has been of the greatest value and importance in the work of the Council; it has been used in arranging joint meetings and printing proceedings of them; in supplementing the Societies' Fund; in printing circulars, and in other ways as has proved desirable; it has twice been augmented by subscription, and it is well that it should be somewhat further increased.

The second joint meeting was held March 27, 1893, also at the Museum of Natural History, in honor of the late Professor John Strong Newberry; addresses were delivered, and the proceedings were published. On April 28, 1893, the Council resolved to establish by subscription a fund to be known as the John Strong Newberry Fund for Original Research, which now amounts to about \$1,200. Grants for the aid of original investigation from accrued interest on the Fund have been made to Dr. Arthur Hollick in Geology; to Mr. Gilbert Van Ingen in Paleontology, and a third grant has been recently authorized in Botany or Zoology. The Third Annual Directory, issued in August, 1893, shows that the membership had increased to 724.

The New York Entomological Society was admitted into the Alliance in March, 1894. The Fourth Annual Directory, issued in July of that year, shows an increase in membership to 818.

After approval by all the Societies and by the Council, an Act of Incorporation of the Council was introduced into the New York Legislature in 1895, and became a law on June 5th. Pursuant to this law, a new Constitution was adopted September 17, 1895. The 5th Annual Directory, July, 1895, contains the

names of 939 members; the 6th contains 1,015 names, and the 7th 1,055.

On March 16, 1898, a reception and dinner was held at the Hotel Savoy, which gave so much pleasure as to form the reason for our assembling here again to-night.

The 8th Directory, issued last fall, shows that at that time the membership had increased to 1,069; it is now known to be over 1,100—that is to say, about twice as large as in 1892-93. This great increase in the membership of the scientific societies is a certain index to the scientific progress of the city, and that this Alliance has contributed much to this well-known remarkable progress there can be no doubt.

The element that is most needed now, as it was at the formation of the Alliance, is a building which will serve as a home for the societies, where all their meetings can be held and where their proceedings and lectures may best attract more public attention; the corner-stone for this building has recently been provided by Mrs. Esther Herrman, whose generous gift of ten thousand dollars, made to the Council, brings the great desideratum nearer than it ever has been before.

GEOLOGICAL SOCIETY OF WASHINGTON.

At the 89th meeting of the Society, held in Washington, D. C., March 22, 1899, Messrs. W. C. Mendenhall and F. C. Schrader, of the U. S. Geological Survey, talked of the reconnaissances made by them the past field season in Alaska, while they were under detail with the military exploring parties sent out by the War Department.

Mr. Mendenhall spoke of a reconnaissance from Resurrection Bay to the Tanana River. He said the route followed by the military exploring party to which he was attached extended from Resurrection Bay, on the southeast shore of Kenai Peninsula, to the Tanana River, at the mouth of the Delta, one of its southern tributaries. The western continuation of the St. Elias Range was crossed by following up the valley of the Matanuski, which rises north of these mountains in a vast marshy plateau on which branches of the Copper and Sushitna Rivers also rise. Beyond this plateau extends the lofty Alaskan Range, with peaks 14,000

feet in height. The Delta River cuts a gap through these mountains, through which the explorers traveled.

The greater part of the region traversed was before quite unknown. It presents much diversity in landscape and physical features. These different types, from the snowy barriers along the Pacific to the dreary wastes of the interior, were illustrated by original views.

The geology of the various areas studied was brought out, and something of the history of the land forms as we now find them. But little gold is known in this part of Alaska, and that little is found along the coast and the adjacent parts of the mainland. Many claims have been staked since the boom struck the Cook Inlet country a few years since, and, although one or two of the richest of these yield as high as \$120 a day to the man, the great majority do not pay expenses.

Mr. Schrader described a hasty reconnaissance of a part of the Copper River district. The object of the expedition was to find an all-American route from the coast into the gold districts of the Upper Yukon. A route was found which, with some engineering through three miles of canyon on Lowe River, will probably prove satisfactory.

The Copper is one of the largest rivers on the southern coast of Alaska. It heads far back of the Coast Range, but breaks through it at about 30 miles from the coast and then debouches over its large delta into the sea.

A little west of Mount St. Elias the St. Elias Range divides into two ranges; of these the main continues westward as the Coast Range around the head of Prince William Sound; the shorter range, diverging northwestward, forms the divide between the Copper, on the southwest, and the White and Tanana Rivers, on the northeast. In the fork of these two ranges, back of the Coast Range, lies the basin proper of the Copper. A lobe of the northwest range extending into the basin on the east terminates in the Wrangell group of mountains, culminating in a maximum height of more than 17,000 feet. Between Prince William Sound, on the south, and the Copper Basin, on the north, the Coast Range consists of a mountainous belt about fifty miles broad, with its general land mass rising to a height of 5,000 feet and slightly

tilted toward the coast. Its surface is studded by innumerable barren peaks and short saw-tooth ranges interspersed by glaciers and nevee. Its edges, on both the costal and inland sides, where the mountains break off abruptly, are etched by short, deep canyons and gulches, which carry off the drainage. The canyon of the Copper alone cuts through the range.

The northwest rim of the basin in the open fork of the ranges is poorly defined. It lies in a vast plateau-like tundra at an elevation of nearly 3,000 feet. The interior of the basin is occupied by a plateau-like terrain consisting principally of unconsolidated silts, sands and some gravel. It is horizontally stratified and seems to represent an extensive inland lake-bed or arm of the sea deposit covering several thousand square miles. Through this terrain the Copper River and its tributaries now flow, as a super-imposed drainage, in newly-cut canyon-like valleys, at a depth of five or more hundred feet. As bed rock has scarcely anywhere been reached by erosion, the deposit is probably a thousand or more feet in thickness.

The surface of the terrain slopes gently southward and from the east and west toward the center of the basin, where its elevation is about 1,500 feet. Back from the streams it is dotted by lakelets and some swamp areas, and is nearly everywhere covered by a fair growth of timber and moss, with local areas of luxuriant grass.

At the head of Woods Canyon, where the Copper enters the mountains, all trace of the lake beds ceases, denoting apparently the barrier which confined the lake before the canyon was cut. The natural features were well illustrated by original views.

The rocks in the Coast Range are mostly sandstone, arkoses, slate, mica-schist and quartzites. On its north base some green amphibolite schist occurs. This schist seems also to form the southwest base of the Wrangell group, but the group itself seems to be mostly volcanic rocks, of which the northwestern end appears to be principally red rhyolite.

WM. F. MORSELL.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 498th meeting of the Society was held at 8 p. m. on March 18th, at the Cosmos Club.

The first paper was by Dr. Artemas Martin on 'Triangles whose angles are 60° or 120° and sides whole numbers.'

From the equation $x^2 - 2xy \cos \phi + y^2 = z^2$ in which x, y, z denote the sides of any plane triangle and ϕ the angle included by x and y , the author deduces the general values

$$x = p^2 - q^2, y = 2pq - 2q^2 \cos \phi, \\ z = p^2 - 2pq \cos \phi + q^2.$$

When $\phi = 60^\circ$, the sides are

$$x = p^2 - q^2, y = 2pq - q^2, z = p^2 - pq + q^2;$$

and when $\phi = 120^\circ$, they are

$$x = p^2 - q^2, y = 2pq + q^2, z = p^2 + pq + q^2.$$

He determines the limitations of the values of p and q for both cases. The smallest triangle for $\phi = 60^\circ$ is 8, 3, 7; the smallest for $\phi = 120^\circ$ is 3, 5, 7.

Numerous examples were given and tables of such triangles were submitted.

Mention was made of a paper on 'The Theory of Commensurables,' by Edward Sang, published in the Transactions of the Royal Society of Edinburgh.

The second paper was by Mr. Lyman J. Briggs on 'Electrical Methods of Investigating the Moisture Temperature and Soluble Salt Content of Soils.' The abstract of this valuable paper has not yet come to hand. The third paper was by Mr. C. K. Wead, on 'Applications of Electricity to Musical Instruments.' Mr. Wead said in part:

Electricity is to-day practically applied on a commercial scale to musical instruments in three ways: (1) As a motive power to blow organs and operate self-playing instruments. (2) To operate the pallets of large organs by means of the electro-pneumatic action patented and introduced by Barker in England in 1868, and shown at the Centennial Exhibition in 1876 by Roosevelt, of New York. (3) To control the application of power to the keys of a piano, the electric circuits being governed by the perforated paper sheet patented to Seytre in France in 1842 and to Bain in England in 1847.

Patents have been granted for specific mechanisms for applying electricity to ring bell chimes and play guitars; to record the music played on a keyboard instrument; to sustain in-

definitely the vibrations of a piano-string by impulses from an electro-magnet supplied with an intermittent current of proper frequency, and to produce 'electrical music' by the simultaneous action upon a loud-speaking telephone of several currents of proper pitch and wave-form synthesized in the line-wire. If these last two inventions shall enjoy any considerable popularity they will inevitably influence, to a marked degree, musical ideas and philosophy.

E. D. PRESTON,
Secretary.

PHYSICS CLUB OF NEW YORK.

THE teachers of physics in secondary schools of New York City have formed an organization to promote efficiency in the teaching of physics. The more specific objects of the club will be to cultivate a personal acquaintance and interchange of thought among laboratory men; to secure the cooperation of the departments of physics in the colleges; to discuss matters of interest concerning laboratory methods, apparatus, new books and kindred matters.

The officers for the present year are: President, Frank Rollins; Vice President, Albert C. Hale; Secretary, A. T. Seymour; Treasurer, S. A. Lottridge. The Executive Committee consists of the officers and Messrs. R. H. Cornish, B. M. Jaquish, G. C. Sonn. The membership is limited to 30. There are at present 29 members. The next meeting will be held at the Teachers' College, April 22, 1899.

A. T. SEYMOUR,
Secretary.

SUB-SECTION OF ANTHROPOLOGY AND PSYCHOLOGY OF THE NEW YORK ACADEMY OF SCIENCES.

THE annual meeting of the Sub-section was held on Monday, March 27th. Dr. Franz Boas was elected Chairman and Dr. Chas. H. Judd Secretary for the ensuing year. The following papers were presented: 'Notes on Chilcotin Mythology,' by Dr. Livingston Farrand; 'Zapotecan Antiquities,' by M. H. Saville and A. Hrdlicka; 'Recent Suggestions for a new Psychology,' by Dr. Charles B. Bliss.

CHAS. H. JUDD,
Secretary.

DISCUSSION AND CORRESPONDENCE.

'THE EVOLUTION OF MODESTY.'

TO THE EDITOR OF SCIENCE: Mr. Havelock Ellis, in his interesting study, 'The Evolution of Modesty,' in the current *Psychological Review*, regards sexual modesty, concealment physiological and anatomical, to be mainly founded in the fear of disgusting others. But wherein, we must ask, does such fear merit the term modesty? Does this kind of fear have any distinct quality? Is it a real species? And in any case is modesty a kind of fear? It appears to me that the fear of exciting disgust in others toward ourselves is, like fear of exciting anger, hatred or any other injurious emotion, not a distinct *genus* of emotion, nor even a species of fear. We have here a more subtle and complex fear than in dodging a stone, but social fears of others' mental attitudes toward ourselves, while they form perhaps a species of fear, yet the particular fear of disgust can hardly be considered as having any peculiar quality over against fear of hatred, and other such emotions. In tracing the history of modesty-actions, Mr. Ellis is tracing not the development of a new psychosis, but merely the development of social fear with reference to a new object, the producing disgust by exposure of the body. Excretory acts in general come to be regarded as disgusting, but if I refrain from spitting in public for fear of disgusting others this can hardly be termed modesty on my part.

Modesty as a really new and significant psychosis is not to be sought in mere objective modesty-actions of the sort which Mr. Ellis considers. We see this mere objective modesty in contrast with true subjective modesty in an incident which Miss Hapgood relates in 'Russian Rambles.' While staying at a country house she was invited by the ladies to go to the ladies' bathing pool, where the Russian ladies went in without costume, and she, to her reluctance, felt obliged to imitate them, since she saw that they plainly thought that the use of clothing at such a time could be only for the hiding of defects. The Russian ladies had no real delicacy or modesty, and had no conception of it, though they had a fear of disgusting. Real modesty as a distinct psychosis, as a regard for one's own feeling rather than for the feelings of others, resenting intrusion, calling for privacy, is a late

product of civilization. Modesty comes finally to be a feeling of reluctance to all vulgar publicity, either as to one's person or mind, a reluctance to all display, a delicacy and refinement, which is late born in evolution, and is, in psychical progress, destined to fuller and higher development, as *versus* the mere fear of disgusting, which, as Mr. Ellis shows, is in decadence in high civilization. Modesty as a mode of self-respect is quite distinct from respect and fear of others' opinions and feelings towards ourselves. Mr. Ellis, indeed, barely mentions (p. 145) modesty as a self-respect, but he seems to connect it with his general treatment. It is noteworthy that modesty should be a term which denotes actions to conceal both defects and excellences, but that real modesty is at bottom as psychosis, a personal delicacy about social conspicuousness, and may have no real psychic connection with either of the other phases, that is, it proceeds not from sensitiveness to one's own excellences or defects as viewed by others, but merely a general reluctance to have one's personality become in any wise open to public gaze and prying.

The other psychic basis of modesty-actions which Mr. Ellis mentions, namely, fear of losing in some way sexual attractiveness, may be objected to on the same ground as not real psychic modesty.

If modesty were as closely related to fear as is claimed we should expect similarity of expression, but the blush of modesty is the converse of the pallor of fear. The most brazen, unmodest woman fears exposure so far as it is disgusting to others. The blush is not the expression of fear, but of self-attentive embarrassment, and secondarily the expression of real psychic modesty. We cannot, with Mr. Ellis, relegate the influence of darkness in restraining modesty to the blushing being thereby concealed; but at least the more obvious and primary factor is that modesty and modesty-action is originally a concealment from the eyes of others, and if the eyes of others are concealed by darkness this action and feeling naturally disappear. Mr. Ellis does not explain how shame is distinct from modesty. Certainly, so far as shame is modesty shocked, it is psychologically modesty.

Our impression on the whole, then, is that while the origin and evolution of modesty-actions are as precautions against causing disgust, yet modesty as distinctive psychic quality which exhibits the same reactions is far later in date.

HIRAM M. STANLEY.

LAKE FOREST, ILL., March 7, 1899.

TRANSMITTED CHARACTERISTICS IN A WHITE ANGORA CAT.

TO THE EDITOR OF SCIENCE: The following observations furnished me by Dr. S. F. Gilbert, of Elysburg, Northumberland county, Pa., concerning his white Angora cat, which I examined a short time since, may be of some interest to those working upon the subject of the transmission of acquired characters.

The cat of Dr. Gilbert is of the white Angora breed. The parentage of this cat is unknown. The mother-cat, referred to above, has the right eye blue and the left yellow, and is about three years old. The kitten of this cat is eight months old, male, and has the right eye yellow and the left eye blue, just the reverse of the mother. The kitten is subject to fits. The fits, as Dr. Gilbert describes them, are of a violent, excitable kind; the kitten running aimlessly about, falling down and scratching, or striking with its feet. These fits, which have occurred twice, lasted about ten minutes. The father of Dr. Gilbert's kitten is a large mongrel with white breast and face, the other parts of the body being zebra-colored.

The mother has had seventeen kittens, eleven of which were white, two having different colored eyes. Two of the kittens were deaf, and in general the breed seems to be very tender and difficult to raise.

JOHN W. HARSHBERGER.

UNIVERSITY OF PENNSYLVANIA.

OSMOTIC SOLUTIONS.

TO THE EDITOR OF SCIENCE: A letter in your columns shows that I ought to explain a special feature of the solutions used for determining osmotic pressure. In my recent paper on 'Physiological Osmosis' (SCIENCE, Vol. IX., p. 206) I cited a one-per cent. solution as having one part of sugar in one hundred parts of

water. These were the proportions actually employed by Pfeffer and given by Ostwald and others. As compared with the conventional composition of a 1% solution they involve a deficiency of one ninety-ninth part of the sugar, which is far within the limits of error in these investigations; nor ought they to mislead any body, as the proportions of this kind of percenticity are explained in the text-books and were given in my paper.

The departure from the conventional proportions of a one-per-cent. solution are not from error nor arbitrary, as the method of comparing the osmotic pressure of different solutions relatively to the gram-molecules of the substances dissolved involves the employment of a uniform quantity of the solvent.

G. MACLOSKIE.

PRINCETON UNIVERSITY, March 25, 1899.

NOTES ON PHYSICS.

WIRELESS TELEGRAPHY.

AT a recent meeting of the Institution of Electrical Engineers, Marconi described his recent work along the lines of wireless telegraphy. In transmitting he uses a 10-inch spark coil and a battery giving about 14 volts and 6 to 8 amperes. For his spark circuit he uses two arrangements, depending upon whether it is necessary to confine the sending of the signals to one direction or not. In the former case cylindrical reflectors are used and capacity is obtained by strips of sheet metal attached to the two spark balls. In the latter case there are no reflectors and one ball is grounded while the other is connected to a vertical wire. A Morse key in the primary circuit makes the signals. The length of the vertical wire depends upon the distance to be covered. A wire 20 feet high will transmit one mile; 40 feet, 4 miles; 80 feet, 10 miles approximately; the distance seems to increase about as the square of the height of the wire. The receiver consists of a coherer, or sensitive tube, about four centimeters long, fitted with metallic pole-pieces and partly filled with nickel and silver filings. When not under the action of the radiation the resistance of this tube is practically infinite, but is reduced by the cohering of the filings

under the action of radiation to from 100 to 500 ohms. This allows a current to flow from a local battery through a relay circuit in which is a vibrating tapper and a sounder, or writer. The former, tapping the coherer, restores the high resistance by separating the filings. The receiver is also supplied, either with the metal strips and reflector or with the ground connection and vertical wire, according as the former or the latter is used in the transmission.

When the reflectors are used the ray within which the signals can be received may be made very narrow; in one case at a distance of $1\frac{1}{2}$ miles it was only about 100 feet. Marconi found that horizontal wires were useless, and accounted for this by the theory that the waves from the vertical wire had a vertical plane of polarization and were, therefore, not absorbed by the surface of the earth.

A number of installations have worked successfully and without difficulty for prolonged intervals and in all sorts of weather. In one case an 18-mile transmission was carried on with an average of about one thousand words per day. With the vertical wire transmitter, hills seem to make little difference with the transmission. In one case a distance of five miles over land, with several intervening hills, was successfully covered.

F. C. C.

BOTANICAL NOTES.

AN ELEMENTARY BOOK ON LICHENS.

IT is a hopeful sign when we find amply qualified men engaging in the work of writing elementary text-books for the use of students in the schools. It has been the duty of the writer on more occasions than he has wished to severely criticise books written for beginners by those who themselves had but little knowledge of the matter treated. It has been at once the scandal and the weakness of the elementary science text-books that they have too often contained very little Science, for the very good reason that their compilers were unacquainted with Science. Some time ago Dr. Albert Schneider published a large treatise on the lichens, which at once proved his profound knowledge of the subject as well as his ability to communicate it clearly and forcibly. It is not necessary that

we should agree with the views as to the nature of lichens held by Dr. Schneider in order to enable us to appreciate the value of the service which he has rendered to the cause of Lichenology in bringing out first his large 'Text-Book' and next his 'Guide.' The latter is intended for the use of beginners and amateurs, and since it is the only book which is adapted to their use it is of especial interest. It is now possible for a student to take up the study of these curious and very difficult plants with a reasonable hope of success. The Boston publisher, Whidden, has brought it out in an attractive form.

A TEXAS SCHOOL OF BOTANY.

THE welcome announcement is made that a School of Botany has been established in the University of Texas, to become operative with the next University year. It will be under the directorship of Professor Doctor William L. Bray, of the chair of botany. The University of Texas has been noted for its progressive spirit, and this is but another illustration of the wise policy of its administrators. We learn that, in addition to the usual University instruction in morphology, physiology, ecology, etc., especial attention will be given to the botanical survey of the State. To this end the School of Botany proposes to cooperate with local botanists, secondary affiliated schools, scientific societies, etc., in all quarters of the State. Under the direction and leadership of an energetic and enthusiastic body of workers in the University, the botanists of Texas may well hope to accomplish much. The State of Texas is to be congratulated upon this forward step.

FALSE 'AIDS' IN BOTANY.

THIS is the time of the year when the country is flooded with circulars describing all sorts of 'aids' for use in teaching or studying botany. It must be that these worthless things are bought by ignorant teachers or school boards, for otherwise they would not be advertised so freely. We have before us one of the old-style 'Plant Analysis' sheets, published by E. R. Good, of Tiffin, Ohio, which proves that in some portions of our country the botanical world is supposed to have remained absolutely at rest for the past twenty-five or thirty years. As a

leaf from quite ancient history in botany one of these sheets is interesting, but as an aid in modern botany it is simply ridiculous.

From J. M. Olcott, of Chicago, we have another reminder of the past in the form of a perforated sheet of paper called 'A System of Plant Study,' which we are told is a sample of the sheets which make up a book 'containing space for mounting and fully describing fifty-one botanical specimens,' and in addition 'full directions for collecting, pressing, mounting, photographing, analyzing and preserving plant forms and specimens.' Of course, no botanist will have anything to do with such trash, but for the non-botanical it may be well to say that this is *not* the way that botanists make herbaria and describe plants. The pupil who is so unfortunate as to use such an 'aid' will have to unlearn practically everything he learns from it.

By all odds the worst thing which has come to our attention recently is the 'Teacher's Botanical Aid,' sent out by the Western Publishing House of Chicago, and consisting of twenty-eight charts, about two feet by three, on which are rough copies of many of the illustrations found in the older text-books of botany. The copying has been done by careless or incompetent hands, so that, in spite of the author's statement that they 'will prove a direct aid in teaching drawing,' we are compelled to say that they are not only inaccurate botanically, but quite shocking from the artistic standpoint. The author intends these charts to be used in Nature Study, so that we are to have our children's time taken up by 'reciting' from these drawings under the impression that they are studying Nature. The teachers of Nature Study who know Nature, and 'who have depended for years upon their own resources' (to quote the author's words), will not think of putting these charts between the pupil and Nature, but we fear that the unprepared and uninformed may be induced to use them. If the charts were accurately drawn they would be of doubtful value in Nature Study, but with all their glaring inaccuracies they are worse than useless.

MINNESOTA BOTANICAL STUDIES.

No other State in the Union can boast of such high class work in botany as that which is pub-

lished in the Minnesota Botanical Studies as a part of the publications of the State Geological and Natural History Survey. Appearing at intervals in the form of a periodical, the 'Studies' are unique among the botanical publications of the country. Here is a case of the endowment of research which is to be commended to other States. Eight titles appear in the current number (Part II., Second Series) including 'Seedlings of certain woody plants, Comparative anatomy of hypocotyl and epicotyl in woody plants, Seed dissemination and distribution of *Razoumofskya robusta*, Observations on Constantinea,' etc., etc.

CHARLES E. BESSEY.

THE UNIVERSITY OF NEBRASKA.

THE BRAIN OF HERMANN VON HELMHOLTZ.

PROFESSOR DAVID HANSEMAN, of the University of Berlin, has contributed to the *Zeitschrift für Psychologie* (Part I. of Volume XX., issued on March 7th) an account of his examination of the brain of the late Professor von Helmholtz. Death was due to apoplexy and occurred on September 8, 1894, when Helmholtz was 73 years of age. The circumference of the head outside the scalp was 59 cm. and of the skull 55 cm. The width of the skull was 15.5 cm. and its length 18.3 cm. The cephalic index was consequently 85.25, which represents a broad head. The size of the head was about the same as that of Bismarck and slightly smaller than that of Wagner, both of whom had large heads. Darwin's head, on the other hand, was only 56.3 cm. in circumference. The weight of the brain with the coagulated blood was 1700 g. and without the blood about 1440 g., which is nearly 100 g. heavier than the average. It is, however, now generally recognized that the weight of the brain alone is not an index of mental capacity. The convolutions are more important, and here the examination of von Helmholtz's brain showed that the sulci were peculiarly deep and well marked, this being especially the case in those parts of the brain which the researches of Flechsig have shown to be concerned with associations. The frontal convolutions are so deeply cut by numerous sulci that it is difficult

to follow the recognized fissures. The article contains two photographs of the brain taken from plaster casts. The brain itself has not been preserved.

We are informed, both on the authority of von Helmholtz himself and as the result of the post-mortem examination, that he had been in youth somewhat hydrocephalous, which was also the case with Cuvier, who had one of the heaviest (1830 g.) brains known. It has been maintained by Perls, and more guardedly by Edinger, that hydrocephaly in youth is an advantage in enlarging the skull and giving the brain space for growth. Hansemann thinks that the pressure on the brain resulting from slight hydrocephaly is an adequate anatomical explanation of unusual intelligence. He refrains, however, from recommending the making of geniuses by injecting fluid into the skulls of babies.

SCIENTIFIC NOTES AND NEWS.

A MEETING of the Council of the American Association for the Advancement of Science has been called by the President, Professor F. W. Putnam, and the Permanent Secretary, Dr. L. O. Howard, on Tuesday, April 18th, at 4:30 p. m., at the Cosmos Club, Washington, D. C.

THE New York Academy of Sciences will hold its annual exhibition and reception on Wednesday and Thursday, April 19th and 20th. As has been the case in other years, the first evening will be reserved for members of the Academy and specially invited guests, while a large number of those interested in science will be invited to be present on the second evening. On Thursday afternoon students of the universities and schools will be invited to attend. Tickets for Thursday afternoon or evening can probably be obtained from Professor William Hallack, Columbia University, Chairman of the Committee of Arrangements.

THE Committee of Organization of the International Geological Congress, which meets at Paris from the 16th to the 28th of August, 1900, is as follows: President, M. Albert Gaudry, professor in the Museum of Natural History; Vice-Presidents, MM. Michel Lévy and Marcel Bertrand; General Secretary, M. Charles Barrois.

DR. G. W. HILL has declined to accept the

Damoiseau Prize, which was awarded to him by the Paris Academy of Sciences last December.

MISS CATHERINE WOLFE BRUCE has, through Professor J. K. Rees, given \$10,000 to Columbia University, to be used for the measurement and discussion of astronomical photographs. Miss Bruce's gifts to the department of astronomy amount to \$22,100.

AT the recent session of the Legislature of Oregon the office of State Biologist was created, whose duty it is to conduct investigations on and develop the biological resources of the State. Professor F. L. Washburn, of the University of Oregon, has been appointed to the office by the Governor. A small appropriation was made for experiments in propagating Eastern oysters in Oregon waters. Professor Washburn has been working along this line for three years, and results of artificial fertilization are coming to light. Some young Eastern oysters hatched and grown in Yaquina Bay, Oregon, have recently been received.

DR. W. S. CHURCH has been elected President of the Royal College of Physicians, London.

AT the fourth annual meeting of the North Carolina Section of the American Chemical Society, the retiring President, Dr. F. P. Venable, made an address on 'The Nature of Valence.' Dr. Charles Baskerville was elected President of the Section.

AT the last meeting of the British Institution of Mechanical Engineers, Mr. Arthur Tannett Walker, a member of the Council of the Iron and Steel Institute, was elected a Vice-President in place of the late Sir Douglas Galton.

PROFESSOR R. S. WOODWARD, of Columbia University, will represent the University at the Jubilee celebrations of Sir George Stokes, to be held at Cambridge in June.

PROFESSOR HENRY S. CARHART, of the department of physics of the University of Michigan, has been granted a year's leave of absence.

M. NAUDIN, the French botanist, has died at the age of 83 years.

MADAME MICHELET, who shared with Jules Michelet the preparation of his books on natural history, has died at Paris.

A WOMAN assistant to the New York State

Entomologist will be selected by civil service examination on April 22d. The duties are clerical, but require some scientific knowledge, and entomology is part of the examination. At the same time a Janitor of the Geological Hall will be chosen, with a salary of \$1,200. This appears to be more than twice the salary of many museum curators.

DR. HANS DELBRÜCK, professor of history in the University of Berlin, has been fined 500 Marks and censured by the Prussian disciplinary court for criticising the action of the government in expelling Danes from North Schleswig. The prosecution proposed that Professor Delbrück be transferred from Berlin to another university. There are evident limitations to academic freedom in Germany.

THE Royal College of Surgeons, of England, was founded by royal charter in 1800, and a committee of the College has been appointed to decide whether its centenary should be celebrated and, if so, in what manner.

A COLORADO Ornithological Association has recently been organized, with Dr. W. B. Bergtold as the first President.

THE French Physical Society held its annual exhibition on April 7th and 8th.

THE opening ceremony of a Spinoza Museum took place at Rhynsburg, near Leyden, on March 24th, in the house where Spinoza lived during the last years of his life, and which has been restored in the 17th-century style. Professor Bolland, of Leyden University, delivered a speech on the life and work of Spinoza.

COMMUNICATION between England and the Continent was obtained on March 27th by the Marconi system of wireless telegraphy. The stations were at South Foreland and Wimreux, 32 miles apart. The Morse code was used, and the messages were read as distinctly as though the termini had been connected with wires.

THE gift from Mr. Llewellyn W. Longstaff of £25,000 towards a British Antarctic expedition, with the £15,000 already subscribed, assures the sending of an expedition in 1900 to cooperate with that from Germany. The Berlin Geographical Society has published a chart indicating the routes that might be followed by the two expeditions. It is proposed that the British ex-

pedition shall confine itself chiefly to the Pacific side of the Antarctic, while the German expedition explores the side facing the Atlantic and Indian Oceans.

News has been received from the *Belgica*, of the Belgian Antarctic expedition. The extreme latitude reached was 71 degrees, 36 minutes south, longitude 92 degrees west. Maps were prepared of Hughes Bay and Palmer's Land, south of the South Shetland Islands.

THE expedition of Mr. H. O. Forbes and Mr. Ogilvie Grant to the Island of Socotra has returned, after successful explorations. The island has been mapped and its geological features and its fauna thoroughly studied.

It is stated in *Nature* that the Russian expedition for taking meridian measurements in Spitsbergen will leave St. Petersburg on May 1st. Two steamers have been placed at the disposal of the expedition by the Russian Ministries of Marine and Ways and Communications, and the Minister of Finance has granted 50,000 roubles for two years. M. Bjalnizki, the zoologist, and Dr. Bunge, the Polar explorer, will accompany the expedition, which will be under the leadership of Staff-Captain Sergievski.

AN international congress against the abuse of alcoholic liquors was held in Paris from April 4th to 9th. The subjects considered included medical science and hygiene, political and social economy, legislation, instruction, education and propaganda.

THE Autumn Congress and Exhibition of the British Sanitary Institution will be held at Southampton on August 29th and following days.

THE extensive and valuable library of works in natural history collected by the late Professor Mariano de la Paz Graells, as also the botanical library of the late Professor Axel Blyt, is offered for sale by Felix M. Dames, of Berlin, from whom catalogues can be obtained.

THE annual dinner of the British Institution of Civil Engineers took place on March 15th. Speeches were made by the President, Mr. W. H. Preece; Lord Wolseley, Lord Claude Hamilton and Mr. W. L. Jackson.

WE called attention recently to the recommen-

dation of the Select Committee of the House of Commons on the Museums of the Science and Art Department that the Frank Buckland Fish Museum should be abolished. The *London Times* states that on March 15th a memorial with a large number of signatures, including those of representatives of many piscatorial societies and the chairmen of various provincial fishery boards, was presented to the Duke of Devonshire and Mr. Ritchie, praying that this decision be withdrawn. The memorialists point out that the Select Committee consisted of 15 members, of whom seven only approved the report; three, including Sir John Gorst, voted against it, and five abstained. Against the opinion of Sir John Donnelly and Major-General Festing is cited that of Sir Richard Owen, who considered that the collection would be a most valuable appendage to the Salmon Fisheries Commission and Office. The memorial relates the history of the museum, and submits suggestions for extending its usefulness as suggested on different occasions by the Prince of Wales and by Professor Huxley. For this the cooperation of the Board of Trade is considered essential. It should, it is submitted, be made a part of the duties of the Inspectors of Fisheries to preserve and deposit in the Museum of Economic Fish Culture any objects of permanent interest which may come under their notice, together with photographs or models of improvements in fish-passes, fish culture apparatus and appliances, and other matters useful for reference or record; while the Inspectors' knowledge and varied experience may perhaps be further utilized for the public benefit, by lectures in connection with the museum. The Secretary and Inspectors of the Fisheries Department, together, perhaps, with representatives of the Fishmongers' Company, or other important bodies connected with the sea and river fisheries, should, it is suggested, be appointed visitors to advise on and aid in the management of the museum.

UNIVERSITY AND EDUCATIONAL NEWS.

SIR WILLIAM MACDONALD has made another munificent gift to McGill University. The gift is for the School of Mining and provides for a lecturer, a demonstrator, an assistant and a com-

plete staff of mechanics, which, with his recent endowment of the professional chair, gives that department a complete staff. It also provides for the establishment of a Summer School in Mining. Sir William's present gift is about \$400,000, and it raises the total amount that he has given to McGill University to over \$3,000,000.

MR. WILLIAM K. VANDERBILT has made a donation of \$100,000 to Vanderbilt University for the erection of a new dormitory on the campus.

It is reported that the sum of over \$250,000 has been subscribed toward an endowment for Brown University. A committee is endeavoring to collect \$2,000,000, which it is intended to devote to strengthening the departments already existing in the University.

A BILL has passed the Kansas Legislature appropriating \$55,000 for the erection of a new chemistry building at the State University.

By the will of the late Senator Justin S. Morrill, of Vermont, \$1,000 is given to Vermont University, for the establishment of a scholarship.

MRS. FREDERICK C. T. PHILLIPS, of Lawrence, L. I., has given Harvard University an endowment of \$50,000, the income to be used for the purchase of books in English literature.

THE Royal Geographical Society has offered £400 a year for five years' maintenance of a school or institute of geography at Oxford on condition that the University contribute an equal sum. The common University fund will contribute £300, and it is expected that the University chest will add £100. The school will be under the direction of the present reader, Mr. H. J. Mackinder, and an assistant and two lecturers will be appointed.

IN addition to its great Lick Observatory, the University of California is erecting an astronomical observatory for the use of students. It contains a central dome 25 feet in diameter, which will contain a 16-inch telescope, and four domes for smaller telescopes.

DEPARTMENTS of Mining Engineering and of Mechanical Engineering have been added to

the School of Engineering of the University of Kansas.

THE College of Agriculture of Cornell University will conduct a school of nature-study at Ithaca for six weeks, beginning July 6th. Nearly 25,000 teachers in New York State are now receiving, at their own request, the Nature-Study publications of the College of Agriculture, and it is believed that many will be glad to attend a summer school devoted to this subject.

DR. JOHN T. NICOLSON, professor of mechanical engineering in McGill University, has accepted an appointment to the chair of mechanical and electrical engineering in the great Technical College recently established at Manchester, England.

At the University of Kansas the following promotions have recently been made: William C. Stevens, associate professor of botany, to professor of botany; Edward C. Franklin, associate professor of chemistry, to professor of physical chemistry; Arthur St. C. Dunstan, assistant professor of physics, to associate professor of physics; Marshall A. Barber, assistant professor of botany, to associate professor of bacteriology and cryptogamic botany; George Wagner, assistant professor of pharmacy, to associate professor of pharmacy; Samuel J. Hunter, assistant professor of entomology, to associate professor of entomology; Walter K. Palmer, assistant in graphics, to associate professor of mechanical engineering; Edward Bartow, instructor in chemistry, to associate professor of chemistry.

AMONG foreign appointments we note the following: Dr. Curt Hassert, of Leipzig, has been appointed associate professor of geography in the University of Tübingen; Dr. Geppert, of the University of Bonn, professor of pharmacology in the University of Giessen; Professor Schilling, of the Institute of Technology at Karlsruhe, professor of mathematics in the University of Göttingen; Dr. Georg Karsten, of Kiel, associate professor of botany in the University of Bonn, and Dr. Dove, of Berlin, professor of botany in the University of Jena. Dr. Georg Bohlmann, docent in mathematics in the University of Göttingen, has been promoted to a professorship.



O. C. Marsh

SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; J. LE CONTE, Geology; W. M. DAVIS, Physiography; HENRY F. OSBORN, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; J. McKEEN CATTELL, Psychology; DANIEL G. BRINTON, J. W. POWELL, Anthropology.

FRIDAY, APRIL 21, 1899.

OTHNIEL CHARLES MARSH.

CONTENTS:

<i>Othniel Charles Marsh</i> (with Portrait): DR. J. L. WORTMAN	561
<i>Some Misapprehensions as to the Simplified Nomenclature of Anatomy</i> : PROFESSOR BURT G. WILDER	566
<i>The Breeding of Animals at Woods Hole during the Month of September, 1898</i> : M. T. THOMPSON...	581
<i>Economics in Manufactures</i> : PROFESSOR R. H. THURSTON	583
<i>Scientific Books:—</i>	
<i>Harkness and Morley on Analytic Functions</i> : PROFESSOR JAMES PIERPONT. <i>Schnabel's Handbook of Metallurgy</i> : DR. J. STRUTHERS. <i>Books received</i>	586
<i>Scientific Journals and Articles</i>	589
<i>Societies and Academies:—</i>	
<i>The Anthropological Society of Washington</i> : DR. J. H. MCCORMICK. <i>Geological Conference and Students' Club of Harvard University</i> : J. M. BOUTWELL. <i>The Torrey Botanical Club</i> : EDWARD S. BURGESS.....	590
<i>Discussion and Correspondence:—</i>	
<i>Duplication of Geologic Formation Names</i> : DR. GEORGE M. DAWSON. <i>On the Names of Certain North American Fossil Vertebrates</i> : O. P. HAY. <i>The Fundamental Law of Temperature for Gaseous Celestial Bodies</i> : PROFESSOR W. S. FRANKLIN.....	592
<i>Notes on Inorganic Chemistry</i> : J. L. H.....	595
<i>The Naples Zoological Station</i>	596
<i>Scientific Notes and News</i>	597
<i>University and Educational News</i>	600

MSB. intended or publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

THE last of the famous trio of American vertebrate paleontologists has passed into the unknown, and the rich legacy of discovery and advancement in biological knowledge which they have bequeathed to the world will ever stand as an enduring monument to their untiring energy and greatness in the realm of thought. It seems, therefore, especially fitting that the unveiling of this splendid monument and the final pronouncing of judgment upon the labors of these truly great Americans should take place in the closing years of the century, notable alike for the variety and brilliancy of its achievements in almost every department of learning.

At the time when the doctrine of Evolution was finally formulated and brought prominently before the thinking world by the labors of Darwin the direct and positive evidence in favor of such an hypothesis was inconclusive and uncertain. True, it received more or less powerful support from Mr. Darwin's own particular field of research, as well as from the embryological studies which the Germans had brought into especial prominence, but the court of the last resort, the tribunal of final judgment in which the case was to be argued and decided was that of the Geological Record, or, in other words, a direct appeal to the animals and plants themselves, which had inhabited the earth in times

past, and whose remains lie entombed in the rocks, mute but unimpeachable witnesses of the story of their becoming and development. It was generally agreed and fully admitted by the foremost thinkers of this critical period that these remains not only once formed parts of living animals, but that they furnish safe guides for the determination of the deposits in which they are found, in the general time scale of the earth's history.

Fossils representing the higher forms were not unknown in Europe at the time this discussion arose, but the specimens from which they were known were in general so fragmentary and lacking in consecutiveness as to furnish little evidence for or against the pretensions of the Darwinian hypothesis. To such an extent was this true that Darwin was compelled to add a chapter in his great work on the Origin of Species, on what he was pleased to call the 'Imperfections of the Geological Record.'

It was at this juncture or shortly afterward that the famous American trio appeared upon the scene, and the tremendous weight of their testimony derived from the unrivaled record of the fossil deposits of Western America has served to take the whole question practically out of the realm of discussion and reduce it to the plane of a demonstrated fact. It has been very truly said that if we regard the truth of Evolution from Mr. Darwin's especial point of view, viz.: that of living plants and animals, we shall conclude that it is a possibility; if we look at it from the standpoint of embryology our judgment must be that it is a probability, but if we examine it from the evidence of paleontology it is no longer a possibility or a probability, but a living truth.

Such, in brief, is the basis of the claims to distinction which the works of these men offer. The share which Leidy took in the

performance of this great work has already been told; the second chapter, devoted to the brilliant discoveries of Cope, has likewise been written, and it remains now to speak of the work of the man whose scientific labors form the subject of the present sketch.

Othniel Charles Marsh was by nature a student and early gave evidence of what his future career was to be by a love for nature and natural objects. As a boy he collected birds, insects, minerals and fossils. He was born in Lockport, N. Y., October 29, 1831, and in 1852 went to Phillips Andover Academy, where he graduated with honors. He afterwards entered Yale, from which institution he graduated in 1860. While in college he became deeply interested in geology, paleontology and mineralogy, and spent two additional years after his graduation in the Sheffield Scientific School at Yale and three years in Germany in pursuit of these branches. In 1866 a professorship of vertebrate paleontology was established in Yale and he was called to fill it. Between this and the time of his graduation he had published a number of important papers on 'Minerals and Fossils,' many of which appeared in the *American Journal of Science*. In 1868 he began his investigations of the Western fossil deposits, and this he was all the better able to do on account of the inheritance of a considerable fortune from his uncle, George Peabody, the banker. It was largely through his influence that this latter gentleman was induced to make the munificent gifts to the University which led to the establishment of the Peabody Museum at Yale.

The record of his discoveries from the time of his appointment to the professorship is one of almost continual triumph in the bringing to light of new and strange forms of life that had inhabited the western hemisphere in the distant past. Pre-

vious to the publication of any of his Western material he contributed some important papers upon the fossil birds and reptiles from the Cretaceous of the East. In 1869 appeared 'Notice of some New Mosasauroid Reptiles from the Greensand of New Jersey,' 'Description of a New Gigantic Fossil Serpent (*Dinophis grandis*) from the Tertiary of New Jersey' and 'Notice of some Fossil Birds from the Cretaceous and Tertiary Formations of the United States.' In 1871 he gave a description of his trip through the Uinta Mountains and the Discovery of the Uinta Tertiary Formation, the uppermost member of the Eocene series. In May of this year he published a description of some new fossil serpents from the Tertiary deposits of Wyoming, and in June of the same year he gave notice of the discovery of the first remains of Pterodactyles that had ever been found in America. In July of the same year he also published the first notice of Tertiary Mammals from the Western beds. In the following year, 1872, he was very active, and some of the most important discoveries of the long list to his credit followed in rapid succession.

It is quite impossible to give more than a brief list of his remarkable finds published during this and the succeeding years; the more important only must suffice. It appears astonishing, however, in the light of our present knowledge of the subject what a keen insight into their meaning and importance he possessed and of which he gave such distinctive evidence in his descriptions. In this year (1872) he proved beyond all doubt the existence of the Pterodactyles in this country, a group which hitherto had been regarded as entirely wanting in the western hemisphere; he described the first remains of the now famous toothed bird *Hesperornis*, although at this time, May, 1872, he did not know of its having possessed teeth. Among the Mosasauroid Reptiles he determined for the first time the following important points

in their structure: (1) position of the quadrate bone, (2) presence of the stapes, (3) presence of the collumella, (4) presence of the quadratoparietal arch, (5) presence of the malar arch, (6) the nature of the pterotic bone, (7) nature of the anterior limbs, (8) presence and nature of the posterior limbs and pelvis and (9) the number of the cervical vertebræ. He also announced in September of this year the discovery of *Ichthyornis*, the curious Cretaceous bird with biconcave vertebræ. Just previous to this came a long list of new genera and species of fossil mammalia from the Bridger Eocene horizon of Wyoming, which, although briefly described, are of the most intense interest and the highest importance in tracing the ancestry of many living mammalian groups. One of the most important of these discoveries among the fossil mammals was the demonstration of the existence of Lemurs, or Primitive Primates, on this continent.

Of scarcely less importance were his contributions of the following year; early in February, 1873, he announced the discovery of teeth, in both jaws, of *Ichthyornis dispar* and established for it, on this account, a sub-class, Odontornithes. This discovery was of far-reaching importance and satisfactorily established the fact that many of the Cretaceous birds are transitional between living birds and reptiles. In this year he devoted much time and space to the consideration of the gigantic mammals of the Eocene, of which the first notices had been given by Leidy from a few fragmentary remains. To Marsh, however, belongs the credit of the final determination of their structure and affinities; he classified them in a separate and distinct order, Dinocerata, a name which has been very widely adopted by naturalists.

In March, 1874, came the discovery which has tended to give Professor Marsh a greater reputation than any other single piece of

work in his entire career. Various futile attempts had been previously made to trace the ancestry of the Modern Horse. Huxley and Kowalewsky in Europe had established the fact that mammals belonging to the equine stem were found in Europe in the early Pliocene and late Miocene, but their attempt to trace the line into any older formations signally failed. Shortly after this Professor Marsh pointed out the equine nature of his Bridger genus *Orohippus*, and was the first to show that the fossil forms of the American Continent furnished every conceivable link between the small polydactyle species of the Eocene and the modern horse. So strong, indeed, is the evidence of this descent that were there no other evidences of evolution to be found among the fossils this would be quite sufficient of itself to establish its truth. In May of this year he published an important paper setting forth these discoveries on the 'Fossil Horses in America.'

In 1875 he published additional discoveries among the Cretaceous birds, and determined for the first time that *Hesperornis* possessed teeth in both jaws. In the succeeding year a series of important papers appeared, giving the principal characters of the *Dinocerata*, *Tillodontia*, *Brontotheridæ* and *Coryphodontia*. Of this latter group he was the first to point out that they were very closely allied to a genus that was described by Owen as early as 1846 from a few fragmentary remains found in the Eocene of Europe, thus giving the first secure basis for a comparison of the older Eocene deposits of the two countries. In this year he was elected Vice-President of the American Association for the Advancement of Science, and in the following year succeeded to the Presidency of the body. His address as the Vice-President upon the 'Introduction and Succession of Vertebrate Life in America' is a notable production and shows the wonderful knowledge he

possessed of the organization of the Vertebrates.

Some notable discoveries which marked the beginning of his extensive and important contributions to the knowledge of the extinct reptiles of the group *Dinosauria* from the Rocky Mountain region were published early in 1877. From this time on, almost up to the time of his death, one discovery after another pertaining to these weird gigantic creatures followed in rapid succession. This subject came to engross his attention more and more, and at the time of his death was the one in which he was the most deeply interested. In 1879 the first discovery of fossil Mammals from the Western Mesozoic was announced, and within the next few years a large number of genera and species were added to the list. His contributions to the subject constitute practically all we know of the American Jurassic Mammalia. In 1880 appeared his first important Monograph on the 'Extinct Toothed Birds of North America,' an important and beautifully illustrated volume published by the United States Geological Survey. In 1886 followed his second Monograph on the 'Dinocerata, An Extinct Order of Gigantic Mammals,' which served to bring together and present in extended form his many discoveries on this subject, a work which was likewise published by the Government Survey. In 1889 two discoveries of more than usual importance were made; one was the finding of a very extensive Cretaceous Mammalian fauna in the Laramie Beds of Wyoming, and the other the discovery of those curious horned Dinosaurs, the *Ceratopsia*, in the same deposits.

It would be impossible to give here even a list of his papers which have contributed so immensely to our knowledge of the extinct Reptilia. It is in this difficult group especially that his splendid knowledge will be so sadly missed, and it will, indeed, be

many years before any of the younger generation of paleontologists who survive him can hope to acquire the information of these various groups which he possessed. It was his intention and special desire to embody this knowledge in separate monographs, to be published by the Geological Survey, several of which were in an advanced state of completion at the time of his death. He had also projected extended works upon other groups. The volumes which he had mapped out and already done a considerable amount of work upon were as follows: The Sauropoda, Theropoda and Ornithopoda, to be in three separate volumes representing the three great divisions of the Dinosauria. Last year the Geological Survey issued a preliminary volume from him on the North American Dinosaurs. He also had a volume projected upon the Mesozoic Mammalia and one upon the Bronthotheridæ.

The scientific world at large had a just appreciation of his merits, and he was largely rewarded by many marks of distinguished consideration. He was elected a member of nearly every scientific society of note in Europe and America. In 1875 he was elected Vice-President of the American Association for the Advancement of Science, and in the year following he became President. In 1877 he received the Bigsby Medal from the Geological Society of London for the most distinguished researches in geology and paleontology. In 1882 he was chosen President of the National Academy of Sciences, a position which he held for two terms of six years each. In the same year he was chosen Paleontologist of the U. S. Geological Survey, a position which he held for ten years. He was also made honorary Curator of Paleontology in the U. S. National Museum, and held this position at his death. In 1886 the University of Heidelberg conferred on him the degree of Ph.D., and in the same year Harvard gave him an

LL.D. Last year he was made a corresponding member of the French Academy, and later he was announced as the winner of the Cuvier prize, one of the most distinguished honors ever conferred upon an American professor.

In his younger days he was a man of tremendous energy and spent much of his time in the field exploring for fossils, frequently far from the outposts of civilization. These expeditions were often attended with many hardships, and at times no small amount of risk to his personal safety, but wherever a new field offered opportunities for adding something novel, calculated to advance the knowledge of his science, no expense, hardship or danger could deter him from undertaking its exploration. The methods of collecting and preparing these fossils for study and exhibition which he has introduced in the course of his long experience forms the basis very largely of all similar work in almost every paleontological laboratory of the world, and it is a matter of common remark that nearly all the noted collectors and preparateurs have received their training under his immediate influence.

The vast collections on this subject which he has brought together are without doubt the finest and most complete of any in the world, and, when properly installed and exhibited, will make a monument in every way worthy of the greatness of the man who dedicated his life and his fortune to its formation. The influence of his work for advancement in this department of knowledge has probably had no equal in any country, and it is to be hoped that his splendid example of unselfish devotion to the cause of education will not be allowed to go unheeded.

J. L. WORTMAN.

AMERICAN MUSEUM OF NATURAL
HISTORY, NEW YORK.

*SOME MISAPPREHENSIONS AS TO THE
SIMPLIFIED NOMENCLATURE
OF ANATOMY.**

LET it not be interpreted as indifference to the honor of election to an office held by the lamented Joseph Leidy and Harrison Allen if I express even more profound gratification in another action of this Association at its meeting a year ago, viz., the adoption, without dissent, by such of the members as were sufficiently interested to attend, of the 'Report of the Majority† of the Committee on Anatomical Nomenclature' (*Proceedings*, pp. 27-55).

It was then my hope and expectation to lay aside that matter for a year in favor of others already too long deferred. Least of all did I contemplate making it the subject of the present address. The change of plan is due to considerations which may be summarized thus: As investigators our main purpose is to comprehend; as writers and teachers our first duty is to be clear; when, therefore, we have reason to believe that in the minds of our fellows there is obscurity upon a subject of common interest to which we have given particular attention we should avail ourselves of any special opportunity of elucidation, the imperativeness of this obligation being directly proportionate to the personal, professional and official importance of those who seem to need enlightenment.

When, therefore, it is announced that at this meeting the Association will be called upon, in respect to nomenclature, to 'reconsider its acts from the beginning' ('Minority Report,' p. 57); when those who make this announcement are among the original members of the Association and its only surviving past Presidents; when, upon both sides of the water, there have

been published reports, articles, reviews and paragraphs in books* containing, however unintentionally, statements so inadequate, exaggerated, or even inaccurate, as to mislead those not themselves acquainted with the facts; and when, finally, it is probable that the facts are more familiar to me than to any other single individual, it becomes not merely my privilege, but my duty, to share my information with the members of this Association and with others interested who may have lacked the time or opportunity to gain it hitherto.

So numerous are the misapprehensions as to the nature of the simplified nomenclature and the purposes of its advocates that it is impossible to consider them all fully upon the present occasion; some, indeed, will be merely stated in the hope that such

* 1. Verhandlungen der anatomischen Gesellschaft auf der neunten Versammlung, in Basel, April, 1895. *Anat. Anzeiger*; Ergänzungsheft zum X. Band; p. 162.

2. His, W.—Die anatomische Nomenclatur. Nomina anatomica. Verzeichniss der von der Anatomischen Gesellschaft auf ihrer IX. Versammlung in Basel angenommenen Namen. Eingeleitet und im Einverständniss mit dem Redactionsausschuss erläutert. *Archiv für Anatomie und Physiologie. Anat. Abth.*, Supplement Band, 1895. O., pp. 180; 27 figs., 2 plates, 1895; [pp. 6-7].

3. Herr Burt Wilder und die Anatomische Nomenclatur. *Anat. Anzeiger*, XII., 446-448, Oct. 30, 1896.

4. Kölliker, A. von.—Handbuch der Gewebelehre des Menschen. Sechste Auflage. Zweiter Band. Nervensystem des Menschen und der Thiere. O., pp. 874, 845 figs. *Leipzig*, 1896; [p. 814].

5. Dwight, Thomas.—Wilder's System der Nomenclatur. *Ergebnisse der Anatomie und Entwicklungsgeschichte*, 1897, pp. 471-479.

6. Baker, Frank.—Review of the foregoing. *SCIENCE*, VII., 715-716, May 28, 1896.

7. Baker, F., and Dwight, T.—Report of the Minority of the Committee on Anatomical Nomenclature. *Proceedings of the tenth annual session of the Association of American Anatomists*, December 28, 1897, pp. 55-57.

8. Reviews of Mills, 'The Nervous System and its Diseases,' in various medical journals; 1898.

* Address of the President at the opening of the eleventh annual session of the Association of American Anatomists, December 28, 1898.

† F. H. Gerrish, Geo. S. Huntington and myself.

statements may carry their own correction. Certain points were presented two years ago.* If, in a few instances, I repeat what I have previously published, precedent for so doing may be found in these words of Huxley :

"When objections are ignored without being refuted or even discussed, I suppose the best way is to emphasize them afresh." *Zool. Soc. Proceedings*, 1883, p. 139.

Misapprehension I.† That the 'Majority Report' embodies the positive convictions of one member and the merely passive acquiescence of the other two.—Such an impression not only might be, but actually has been, produced by the 'Minority Report.' Nothing could be less accurate or just.

The members of this Association need only be reminded that the two other signers of the 'Majority Report' are among the more active of our associates; that they are writers, and are, or have been, practi-

tioners; and that they are teachers of anatomy in long-established medical schools.

But even more significant in this connection is something best known to those who know them best. These men, in a notable degree, combine intellectual independence with liberality; in other words, they are conspicuously free from two qualities shared by the human species with certain other mammals, *viz.*, uncritical imitation, on the one hand, and, on the other, hostility toward what appears to be new merely because they are personally unfamiliar with it.

With regard to the matter in question, as was expressly stated in the 'Majority Report' (p. 31, § 2, 5), "with few exceptions the terms recommended had been adopted by each member individually, and prior to the conference at which joint action was taken."*

Notwithstanding the nature of their convictions, if the larger number of those in attendance at the present session decide to materially modify or even reverse the action of a year ago, the majority of your committee will offer no factious opposition.† They will, however, feel none the less proud of their work and confident of its eventual readoption. Their sentiments may be compared, although somewhat remotely, with those of the surgeon who had devised a new flap for amputation of the thigh. Upon the first trial, just as the operation was triumphantly completed, an overdose of chloroform killed the patient. "Too bad," said the surgeon, "but at any rate he'll go to heaven with the best flap that ever was made."

* For the complete appreciation of the situation it should perhaps be added that the two other signers of the 'Majority Report' were appointed on the Committee respectively by the two signers of the 'Minority Report' while serving as Presidents.

† At the closing session (December 30, 1898) of the eleventh meeting the second Report of the Majority of the Committee was adopted by the Association.

* *Neural Terms*, International and National, *Journal of Comparative Neurology*, VI., December, 1896, pp. 216-352, including seven tables. Parts VII.-IX. have also been reprinted under the title 'Table of Neural Terms, with Comments and Bibliography,' including also 'Suggestions to American Anatomists.' Copies of the entire paper and also of the 'Tables,' etc., were sent to all members of all committees on nomenclature, here and abroad, and to many other anatomists and neurologists. To them were also sent copies of the 'Table,' etc., and the latter was still more widely distributed to others more or less directly interested in the subject. My reprints of the entire paper are exhausted; of the 'Table,' etc., some copies remain that will be sent upon application. The larger part of the paper is contained in the lecture 'Some Neural Terms,' in 'Biological Lectures' [at the Marine Biological Laboratory] for 1896-7. The 'Errors and Omissions' detected in my Lists of Neural Terms have been corrected in the *Journal of Comparative Neurology*, VIII., pp. li-lii, July, 1898; a leaflet reprint has been inserted in copies of 'Neural Terms' and of 'Table of Neural Terms' distributed since March 30, 1896, and will be sent upon request to those who received copies prior to that date.

† The succeeding misapprehensions will be designated simply by Roman numerals.

II. *That any action of the Association with respect to the use of terms has binding force.*—From certain expressions it might be inferred that the adoption of a report on nomenclature was tantamount to the enactment of rules or by-laws, conformity to which constitutes an indispensable condition of the maintenance of membership. On the contrary, the recommendation and acceptance of certain terms merely entitles them to particularly respectful consideration and throws upon those who prefer others the burden of proof that those others are superior. As an illustration of the impunity with which somewhat stringent injunctions may be disregarded may be mentioned the following: In the *Anatomischer Anzeiger* (March 3, 1897, pp. 323–329), in a paper by Dr. Edward Flatau, 'Beitrag zur technischen Bearbeitung des Centralnervensystems,' prepared in the Anatomic Institute at Berlin, the Director of which is Professor Waldeyer, a member of the B. N. A. Commission and of the Gesellschaft that recommended *Dura mater encephali* and *Pia mater encephali*, the mononyms *dura* and *pia* occur two and four times respectively, and the authorized polyonyms are conspicuous by their absence.

III. *That action of the majority of a committee should be delayed indefinitely by the absence or unpreparedness of the minority after due notice is given.*

IV. *That the condemnatory phrases of the 'Minority Report' can, in any considerable degree, be justly applied to the actual contents of the 'Majority Report.'*

V. *That the non-adoption of a term, whether from the German list or my own, constitutes a declaration against it.*—It signifies merely a suspension of judgment and a postponement of action.

VI. *That differences of usage or recommendation between American and foreign anatomists or organizations should be removed in all cases by the abandonment of our position.*

VII. *That the efforts of this Association for the simplification of nomenclature should be paralyzed by the disapprobation of foreign anatomists whose unfamiliarity with what is done in America is to be explained only by an indifference thereto.*—Among numerous instances of this indifference I select one with which my own connection is so remote as to eliminate the element of personal irritation. At the meeting of this Association in December, 1895, there was presented an elaborate 'Report on the Collection and Preservation of Anatomical Material.' It was printed in our *Proceedings* (15–38) and in *SCIENCE*, III., January 17, 1896; was mentioned in several journals and listed in the 'Literatur' in the *Anatomischer Anzeiger*. Yet in September, 1898, practically an entire number of that periodical, twenty-five pages, was occupied by an article on that subject purporting to tabulate and discuss the methods employed in all parts of the world. The whole United States is credited with an article by Mall (*Anzeiger*, 1896, 769–775) and (in a footnote) a 'Note' by Keiller in the *Texas Medical Journal*, 1891–2, VII., p. 425.

VIII. *That terms consisting of a single word each constitute even the majority of the names preferred by me or adopted by this Association a year ago.*—Whatever their abstract preferences, the members of the Committee realize the impossibility of framing such a nomenclature. Two years ago ('Neural Terms,' § 153 *et seq.*) I showed by statistics the baselessness of the misapprehension and characterized it as a 'terminologic phantasm erected by the Germans between themselves and the American Committees.'

More recently, however, the same notion has reappeared in several reviews of a textbook of nervous diseases, commonly with approval, expressed or implied, of the supposed condition. The impression was probably gained from the fact that the author of the book, like myself, prefers single-word

names for as many as possible of the parts most frequently mentioned. Nevertheless, the misapprehension on this point ought to be corrected. The facts are :

First, out of about 540 neural terms in the B. N. A. at least 40, about one-fourteenth, are mononyms.

Secondly, in the 'Majority Report', in Tables C and D, are enumerated 274 terms differing more or less from those adopted by the Gesellschaft; the mononyms number only 103.

IX. That eminence as an anatomist necessarily implies either the capacity or the disposition to deal wisely with questions of nomenclature.—Upon this point I quote from 'Concluding Remarks' in 'Neural Terms,' p. 329:

Caution in Publishing New Terms.—It is true that words needlessly introduced into anatomy have no such embarrassing permanency as is conventionally assigned to synonyms in systematic zoölogy. Nevertheless, for a time at least, they encumber current publications and dictionaries. Hence, however necessary and legitimate they may seem to the framer, neither a new term, nor an old one in a new sense, should be actually published without prolonged consideration, and consultation with at least four individuals representing as many categories of possible critics: (a) an investigator of the same general subject; (b) an experienced teacher; (c) an earnest student; (d) a philologic expert whose admiration for the past has not blinded him to the needs of the present and the future.

Method of Introduction of New Terms.—As urgently recommended by the A. A. S. Committee on Biological Nomenclature, whenever a technical word is used for the first time the author should give in a special note: (a) the Latin form; (b) the etymology; (c) the proper adopted form or paronym for his own language, with the adjective, etc., when applicable; (d) as concise and precise a definition as possible.

X. That among the terms included in the 'Majority Report' any considerable number have been specifically condemned by the Anatomische Gesellschaft or its authorized representatives.

XI. That the grounds of such objections as have been offered are really sound and sufficient.

XII. That the condemnation of a term by an anatomic authority disproves either its intrinsic fitness or its promise of vitality.—On this point there need be adduced only the cases of *radius* and *ulna*, which Robert Hunter denounced as 'ridiculous.'

XIII. That the anatomy of the future is to be based upon the structure and erect attitude of the human body.—The anatomists of the future will be zoötomists first and anthropotomists afterward.

XIV. That every anatomic term should be an absolute idionym, i. e., perfectly explicit in itself.—Since this requirement is implied in the objections to *aula*, etc., by Kölliker, and to *medipedunculus* by His,* there may be properly adduced from the B. N. A. the following terms, whose explicitness is conditioned upon either the context or the actual addition of the words here set in brackets: *clivus* [*occipitalis*], and [*sphenoidalis*]; *processus coronoideus* [*ulnæ*] and [*mandibulæ*]; *processus styloideus* [*radii*], [*ulnæ*], and [*ossis temporalis*]. Unless, indeed, it be granted that a certain degree of explicitness is afforded by the context, every one of the thousands of names of the parts of the human body should be increased by the phrase *corporis humani*.

XV. That the occasional employment, by a member of an Association, or even by a member of its Committee on Nomenclature, of terms other than those adopted by them is, in itself, evidence of deliberate intention.—For example, after using *conarium* for fifteen years in place of 'pineal body,' etc., now that the arguments of Spitzka and H. F. Osborn have converted me to *epiphysis*, *conarium* occasionally gets itself spoken. Indeed, it is easy for me to understand that an unintended but familiar word may be written, re-written, and even overlooked in the proof. The frequency of such lapses could be shown, if necessary, by letters from numer-

*As stated and briefly discussed in 'Neural Terms,' pp. 282-289.

ous correspondents in reply to the query, free from all critical or proselytic tenor, as to whether a given term was used intentionally or by inadvertence.

¶ XVI. *That there is 'imminent danger of the formation of a peculiar anatomic vocabulary in America such as seriously to impede scientific intercourse with other countries.'*—The unsubstantiality of the grounds of this misapprehension may be recognized in the impartial discussion by the brothers Herrick a year ago.* They conclude that there is no reason for serious alarm on this score.

XVII. *That the fundamental principles and characteristic features of the simplified nomenclature can be attributed to any individual in such degree as to warrant calling it by his name.*—In correcting this misapprehension no false modesty shall lead me to belittle what I have done. On the contrary, to the 'Summary of my terminologic progress,' already published in 'Neural Terms,' etc. (pp. 227-237), there shall be added here two items overlooked when that was printed:

1. That the defects of encephalic terminology had been recognized by me as early as 1873 may be seen from the following paragraph in a popular lecture on 'The brain and the present scientific aspects of phrenology,' delivered January 21st, before the 'American Institute,' and reported in the *New York Tribune* of January 22d and in the *Tribune Extra*, No. 3:

"As if these natural hindrances were not enough, the old anatomists fenced in the parts of the brain with the most fanciful and prodigious titles. *Cerebrum* is well enough; the *cerebellum*, being only one-eighth as large, has a longer name, while *medulla oblongata*, *hippocampus minor*, *tubercula quadrigemina*, *processus e cerebello ad testes*, and *iter e tertio ad ventriculum quartum* represent such insignificant parts of the brain as to suggest a suspicion that the nomenclature was established upon no other principle than that of inverse ratio between the size of an organ and the length of its title. At any rate, these fearful names

*'Inquiries regarding tendencies current in neurological literature,' *Jour. Comp. Neurology*, VII., 162-168, December, 1897.

are stumbling-blocks to the student and an almost perfect hindrance to popular knowledge of the brain; no doubt this pleases the ghosts of the old anatomical fathers, and is equally agreeable to many of the present day, both in and out of the profession, with whom Latin is a synonym for learning, and ponderosity of words for profundity of wisdom."

2. My actual efforts toward the simplification of the nomenclature of the brain commenced in 1880, in the preparation of a paper read before the American Association for the Advancement of Science on the 28th of August. The paper was never written out in full, and apparently no abstract was furnished for publication in the *Proceedings*. Somewhat inadequate and erroneous reports were printed in the *Boston Daily Advertiser* of August 30th, and in the *New York Medical Record* of September 18th. But here is a duplicate of the abstract furnished in advance to the Secretary of the Association, and I venture to read it as a contribution to the history of the subject now before us:

"PARTIAL REVISION OF THE NOMENCLATURE OF THE BRAIN.

"A. *Introductory*: The progress of anatomy is impeded by the defects of nomenclature. These defects have been admitted by several anatomists, and a few have endeavored to remedy them. As stated by Pye-Smith, 'the nomenclature of the brain stands more in need of revision than that of any other part.'

"B. *Nature of the Defects*: (1) General. In common with that of the rest of the body, the nomenclature of the brain lacks precision as to the position and direction of parts. (2) In particular the number of synonyms is very large. Most writers employ some names which are vernacular or merely descriptive. Most technical names are compound; many of the single ones are inconveniently long, and some of them are indecent.

"C. *Special Obstacles to a Reform*: (1) The difficulty of ascertaining the priority of terms. (2) The tendency of each nation to adopt purely vernacular terms which have been proposed or incidentally employed by eminent anatomists of that nation.

"D. *Principles Forming the Basis of this Revision*: (1) Technical terms are the tools of thought, and the best workman uses the best tools. (2) Terms of classical origin are to be preferred. (3) Priority of

employment is to be regarded, but should not overbear all other considerations. (4) Of two terms equally acceptable in other respects, to select the shorter. (5) Preference for names of general application over those which have an exclusive application to man or the other primates. (6) To convert some compound terms into simple ones, either by dropping unessential words or by the substitution of prefixes for adjectives. (7) For terms of position, to discard all which refer to the horizon or to the natural attitude of man, and to adopt those which refer to the longitudinal axis of the vertebrate body. (8) For terms of relative position and direction, to employ those used for position with the termination *ad*.

"E. *The Paper Will Indicate*: (1) The terms proposed and their abbreviations. (2) The principal synonyms. (3) The originators of the terms and synonyms and the dates of their first employment, so far as ascertained. (4) The terms which should be wholly discarded. (5) The new terms for new parts, the new terms for parts already known, the new forms of old terms. (6) The subordination of parts to wholes by differences in the kinds of type."

There were present Harrison Allen, Simon H. Gage, Charles S. Minot and probably other members of this Association; the survivors will recall that on cloth sheets were written in parallel columns certain names in common use, together with those which were proposed to replace them. Amongst these were *pons* for 'pons Varolii'; *insula* for 'insula Reillii'; *thalamus* for 'thalamus opticus'; *callosum* and *striatum* for 'corpus callosum' and 'corpus striatum'; *præcommisura* for 'commissura anterior'; *myelon* for 'medulla spinalis,' and *cornu dorsale*, for 'cornu posterius.' This paper constituted the proton (the *primordium*, or 'Anlage,' if you prefer) of my own subsequent contributions, and likewise, so far as I knew at the time, of the simplified nomenclature in America.

Proud as I am of these early propositions, and glad as I should be if they and their subsequent elaborations had been at once unprecedented and sufficient, nevertheless truth, justice and the peculiar conditions now confronting us alike impel me upon this occasion to insist even more distinctly

than hitherto upon the extent to which the ideas and even the specific terms had been anticipated by four other anatomists in this country and in England.

Already in the spring of 1880, although quite unknown to me, there had been published a paper by E. C. Spitzka, 'The Central Tubular Gray' (*Journal of Nervous and Mental Disease*, April, 1880), containing (p. 75, note) the following pregnant paragraph:

"It would add much to the clearness of our terminology, in my opinion, if the adjectives anterior and posterior were to be discarded. Physiologists and anatomists are so often forced to deal with the nerve axes of lower animals, in whom what is with man the anterior root becomes inferior, and what is in the former posterior becomes superior, that they have either been confused themselves or have written confusedly, or finally have, to avoid all misunderstanding, utilized the terms applicable to man alone also for quadrupeds. The nervous axis, however, occupies one definite position, which should determine the topographical designations. What in man is the anterior, and in quadrupeds the inferior, root or cornu is always *ventral*; while what in the former is posterior, and the latter superior, is always *dorsal*. The present treatise is not the proper place for renovating nomenclature, but I have thought it well to call attention to the matter in passing, and in anticipation of a work on comparative neural morphology which I have in preparation."

The concluding words are italicized by me in order that there may be the more fully appreciated the generosity, indeed self-abnegation, exhibited in Dr. Spitzka's commentary* upon my longer paper† of the following year:

"It is with mingled pleasure and profit that I have read the very suggestive paper on cerebral nomenclature contributed to your last issues by Professor Wilder. Some of the suggestions which he has made have been latent in my own mind for years,

* Letter on nomenclature, *SCIENCE*, April 9, 1881. Also in *Jour. Nerv. and Mental Dis.*, July, 1881, 661-662.

† A partial revision of anatomical nomenclature, with especial reference to that of the brain, *SCIENCE*, II., 1881, pp. 122-126, 133-138, March. Also *Jour. Nerv. and Mental. Dis.*, July, 1881, 652-661.

but I have lacked the courage [time?] to bring them before my colleagues. Now that he has broken ground, those who prefer a rational nomenclature to one which, like the present reigning one, is based upon erroneous principles, or rather on no principles at all, will be rejoiced at the precedent thus set for innovations. * * * He who has himself been compelled to labor under the curse of the old system, the *beneath, below, under, in front of, inside, external, between, etc.*, will look upon the simple *ventral, dorsal, lateral, mesal, cephalic, proximal, caudal, distal, etc.* as so many boons. I have no hesitation in saying that the labor of the anatomical student will be diminished fully one-half when this nomenclature shall have been definitely adopted. * * * In proceeding to comment on some of the terms proposed by Professor Wilder, I wish it to be distinctly understood that I do so merely tentatively and to promote discussion; in so doing I feel certain that I am carrying out that writer's wishes. It is but just to state that the majority of the terms cannot be discussed; they are perfection and simplicity combined."

Had Dr. Spitzka completed his proposed work he would doubtless have called attention to our three British predecessors, John Barclay, Richard Owen and P. H. Pye-Smith.

The first, as long ago as 1803, in 'A New Anatomical Nomenclature,' proposed the unambiguous descriptive terms, *dorsal, lateral, proximal*, with their adverbial forms, *dorsad, laterad* and *proximad*, and thus laid the foundation for an intrinsic toponymy.

In 1846 Owen published ('Report on the Vertebrate Skeleton,' p. 171) what I have elsewhere ('Neural Terms,' § 51) called the 'immortal paragraph,' wherein the various phrases for the spinal portion of the central nervous system were replaced by the single word, *myelon*. Twenty years later he uttered ('Anatomy of Vertebrates,' I., 294) a declaration which some of us are disposed to regard as an inspired prophecy:

"Whoever will carry out the application of neat substantive names to the homologous parts of the encephalon will perform a good work in true anatomy." In the third volume of the same work (1868, p. 136) is a list of the cerebral fissures designated, in most cases, by adjectives of a single word each, *e. g., sub-frontal*.

The paper of Pye-Smith (fortunately still spared to us) was entitled 'Suggestions on Some Points of Anatomical Nomenclature,' and appeared in 1877 (*Journal of Anatomy and Physiology*, XII., 154-175, October, 1877). After enunciating certain sound general principles, he declared that 'the nomenclature of the brain stands more in need of revision than that of any other part,' and made several specific suggestions some of which have been adopted by the three American Associations and the Anatomische Gesellschaft:

"The term optic thalamus is a misleading and cumbersome abbreviation of the proper name *thalamus nervorum opticorum*, and the name *thalamus*, without qualification, is at once distinctive, convenient, and free from a false suggestion as to the function of the part. * * * Of all the synonyms of the *Hippocampus minor* (*Ergot* of Morand, *eminentia unciniformis, colliculus, unguis, calcar avis*) the last is the most distinctive, and brings it at once into relation with the calcarine fissure. The *Hippocampus major* may then drop the adjective, as well as its synonym of *cornu ammonis*. The pineal and pituitary bodies are more conveniently called *conarium* and *hypophysis*. * * * The word *Pons* (Varolii) might well be restricted to the great transverse commissure of the cerebellum. * * * *Insula* is a far more distinctive name than any proposed to replace it." Pye-Smith also prefers *vagus* to 'pneumogastricus.' (p. 162).

Those who have done me the honor to read any one of my longer papers on this subject will recall my repeated acknowledgments of indebtedness to these three English anatomists. Not to mention earlier publications, in 1889, in the article 'Anatomical Terminology' ('Reference Handbook of the Medical Sciences,' VIII., 520-522), Professor Gage and I collected from all sources accessible to us 'Aphorisms respecting Nomenclature;' the most prolific sources were the three just named. At the third meeting of this Association, in Boston, December, 1890, I read a paper the title of which was 'Owen's Nomenclature of the Brain,' and which included this paragraph:

"In none of the above-designated publications or in those of other anatomists does it now seem to the

writer that there has been adequate recognition of the terminological precepts and examples that occur in the works of Professor Richard Owen, and the writer takes this opportunity to express his constantly increasing sense of obligation in this regard; had space permitted he would gladly have increased the number and length of the selections from Professor Owen's writings which are embraced among the 'Aphorisms respecting Nomenclature' on pp. 520-522 of the article 'Anatomical Terminology.'"

In this connection may appropriately be mentioned two later but highly significant British contributions toward a simplified and international system of nomenclature.

1. The Latin names for the encephalic segments.—In the seventh edition of Quain's 'Anatomy', edited by William Sharpey, Allen Thompson and John Cleland, in Vol. II., dated 1867, the five 'fundamental parts' (corresponding to what I have called 'definitive segments') are named *prosencephalon*, *diencephalon*, *mesencephalon*, *epencephalon*, and *metencephalon*; and in a foot-note these terms are declared to be "adopted as applicable to the principal secondary divisions of the primordial medullary tube, and as corresponding to the commonly received names of the German embryologists, viz., *Vorderhirn*, *Zwischenhirn*, *Mittelhirn*, *Hinterhirn*, and *Nachhirn*; or their less-used English translations, viz., *forebrain*, *interbrain*, *midbrain*, *hindbrain*, and *afterbrain*."

Notwithstanding several public requests for information as to the source of the Latin segmental names, the historic facts recorded in the above extract were ascertained by me only within the past week; I prefer to believe that they were unknown to the Nomenclatur Commission and to the Anatomische Gesellschaft at the time of the selection and adoption of the Latin names for the encephalic segments as given in the B. N. A. Even, then, however, since the same Latin terms were repeated in the subsequent editions of Quain (1877-1882), I am compelled to regard the transference of *metencephalon* from the ultimate segment to

the penultimate, and its replacement by *myelencephalon*, as constituting a violation of scientific ethics that merits the severest reprobation. *

2. Mononymic designations of the encephalic cavities.—In August, 1882, wholly unaware of my prior suggestion to the same effect (SCIENCE, March, 1881), the late T. Jeffery Parker, professor in Otago University, New Zealand, proposed compounds of the Greek *κοίλα*, with the prepositions, etc., already employed in the segmental names; e. g., *mesocoale*, *prosocoale*, etc. Our mutual gratification and encouragement at the approximate coincidence led to a cordial correspondence that continued until his death. Besides the publications enumerated in the Bibliography of 'Neural Terms,' Parker used celian compounds in two papers on the *Apteryx* (1890 and 1892) and in the 'Text-book of Zoology' by himself and Professor Haswell (1897).

XVIII. That, even in its earliest and crudest form, the 'system' sometimes called by my name could fairly be characterized as 'generally repulsive' and as having 'not the slightest chance of general adoption.' †—On this point it is sufficient to introduce the following letter ‡ from Oliver Wendell Holmes, whose point of view was at once that of the literary critic and the experienced teacher of anatomy in a medical school:

"BOSTON, May 3, 1881.

"DEAR DR. WILDER: I have read carefully your paper on Nomenclature. I entirely approve of it as an attempt, an attempt which I hope will be partially successful, for no such sweeping change is, I think, ever adopted as a whole. But I am struck with the

* The intrinsic merits of various segmental names have been discussed by me in 'Neural Terms,' etc., 326-328, and in the *Proceedings of this Association* for the ninth session, May, 1897, 28-29.

† These phrases occur in the 'Minority Report.'

‡ As a whole or in part this notable document has been printed previously in SCIENCE, May 28, 1881; in 'The Brain of the Cat,' *Amer. Philos. Soc., Proceedings*, XIX., p. 530, 1881; 'Anatomical Technology,' 1882, p. 11; 'Neural Terms', p. 237.

reasonableness of the system of changes which you propose, and the fitness of many of the special terms you have suggested.

"The last thing an old teacher wants is, as you know full well, a new set of terms for a familiar set of objects. It is hard instructing ancient canine individuals in new devices. It is hard teaching old professors new tricks. So my approbation of your attempt is a *sic vos non vobis* case so far as I am concerned.

"What you have to do is to keep agitating the subject; to go on training your students to the new terms, some of which you or others will doubtless see reasons for changing; to improve as far as possible, fill up blanks, perhaps get up a small manual in which the new terms shall be practically applied, and have faith that sooner or later the best part of your innovations will find their way into scientific use. The plan is an excellent one; it is a new garment which will fit Science well, if that capricious and fantastic and old-fashioned dressing lady can only be induced to try it on.

"Always very truly yours,

"OLIVER WENDELL HOLMES."

XIX. *That, at the present stage of the subject, it is possible for any individual, however impartial and well informed, to wholly avert the possibility of misapprehension or even injustice, in attempting to indicate the attitude of living anatomists toward the simplified nomenclature.*—My impartiality may perhaps be challenged, but I am at least familiar with current literature in this respect; moreover, since 1880 I have preserved all letters in which the matter is considered. Probably no one agrees with me absolutely and in every respect. On the other hand, even some frankly avowed opponents now assent to what they would have regarded as quite heretical a few years ago.*

XX. *That whatever misapprehension may exist in this country or abroad as to the degree in which the terms or principles advocated by me are indorsed by others can be justly ascribed to either unfounded declarations or intimations on my part, or to the omission of definite efforts to avert or*

remove such misapprehension.—The enumeration of the conditions that led to the preparation of 'Neural Terms' included (p. 217) the following sentence: "I particularly desire to free the committees, their individual members, and the associations which they represent, from responsibilities not yet assumed by them." More or less explicit and emphatic affirmations to the same effect occur on pp. 273, 295, 299 and 301.*

XXI. *That 'most scholars are repelled by' my 'fantastic terms and defects of literary form.'*—This assertion occurs in the 'review' (No. 6), and presumably refers to the 'system' in its present or recent state. The position taken is apparently impregnable, since for every one who has declared his adhesion there might be named a score who have said nothing about it. Seriously, however, it is not easy to discuss such a proposition without adducing evidence that might fairly be challenged by one side or the other. At any rate, in the present connection I shall omit my more or less intimate friends and correspondents, living and dead; Harrison Allen, W. R. Birdsall, Oliver Wendell Holmes, Joseph Leidy, and E. C. Seguin; William Browning, Joseph Collins, Elliott Coues, H. H. Donaldson, F. H. Gerrish,

*At the meeting of the American Medical Association in Philadelphia, June, 1897, the Section on Neurology and Medical Jurisprudence adopted the following resolution, recommended by the Committee on the Address of the Chairman, W. J. Herdman:

"Resolved, That the Section of Neurology and Medical Jurisprudence endorse the neural terms adopted by the American Neurological Association, the Association of American Anatomists, and the American Association for the Advancement of Science, and so far as practical recommend their use in the work of the section.

C. K. MILLS,
C. H. HUGHES,
HAROLD N. MOYER."

*In the verbal presentation of a paper at this meeting Professor Dwight designated the costiferous vertebrae as *thoracic* rather than *dorsal*, with a consistency both gratifying and encouraging.

Since the action above recorded was taken in June, 1897, it does not, of course, apply to the subsequent adoptions by this Association at the tenth and eleventh sessions; Dec., 1897, and Dec., 1898.

George M. Gould, the brothers Herrick, G. S. Huntington, C. K. Mills, W. J. Herdman, H. F. Osborn, C. E. Riggs, D. K. Shute, Sorenson, Spitzka, O. S. Strong, W. G. Tight, C. H. Turner, A. F. Witmer and R. Ramsay Wright; also past or present pupils or colleagues, T. E. Clark, P. A. Fish, S. H. Gage, Mrs. Gage, G. S. Hopkins, O. D. Humphrey, A. T. Kerr, B. F. Kingsbury, W. C. Krauss, T. B. Stowell and B. B. Stroud. I have now, I think, eliminated all whose more or less complete adoption or approval of my 'system' might be ascribed in some degree to personal considerations.*

There has lately been afforded me, however, the desired opportunity of collating the impressions of a somewhat homogeneous group of scholars, quite unlikely to have been influenced by a disinclination to antagonize my views. Through the courtesy of

*Curiously enough, in the single instance of the apparent operation of personal influence, the individual was of German descent and we had met but once. Prior to our meeting in December, 1895, I prepared a typewritten list of the neural terms that had been adopted earlier in the year by the Anatomische Gesellschaft, and in parallel columns added those preferred by me. Copies of this list were sent to members of the Association as a basis for the anticipated discussion. In January the late Dr. Carl Heitzmann, in acknowledging his copy, accounted at the same time for his absence from the meeting: "My intention was to urge the acceptance of the nomenclature adopted by the German Anatomical Society, deficient as it is, simply to obtain uniformity. * * * Personally I cannot vote against you; hence I rather abstain from coming to the meetings till this matter will be settled."

My response was as follows: "Your letter affects me deeply, and were my efforts toward the improvement of anatomical nomenclature for my own sake or for the present at all it would go far to deter me from further persistence. But I never lose sight of the fact that we of to-day, and even the honored workers of the past, are few and insignificant as compared with our successors, and I do not mean to be reproached by them for failing to do what I can. Do not refrain from writing, publishing or voting against me according to your convictions. It will come out right in the end."

the author of a recent American text-book on 'The Nervous System and its Diseases,' in which the simplified nomenclature is fully and expressly employed, I have been enabled to read all the reviews of it that have thus far appeared. For the sake of homogeneity I have excluded two non-medical journals, the *Revue Neurologique*, which says nothing on the subject of nomenclature, and the *Journal of Comparative Neurology*, which, upon the whole, is favorable. This leaves thirty reviews of a book intended for students; reviews written by practitioners, some of them well-known experts and also teachers of neurology. As such, upon general principles, any modification of the current terminology must be more or less unwelcome to them.

Upon the basis of their attitude toward the simplified nomenclature the reviews fall naturally into four groups, viz.: A, those that ignore the subject (8, about 27 per cent.); B, those that merely mention it (6, 20 per cent.); C, those that condemn the introduction of the simplified terms more or less decidedly (6, 20 per cent.); D, those that commend it (10, 33 per cent.). Without going so far as to reverse the Scriptural saying and claim that 'he who is not against us is with us,' we may infer that the fourteen reviewers in groups A and B were at least not 'repelled' by the simplified terms; on the contrary, many of them call attention to the clearness and accuracy of the anatomic and embryologic sections of the book where, of course, the terms are most conspicuous.

In category C I have included one that might, without real unfairness, have been left in category B; in the *Colorado Medical Journal*, after characterizing the anatomic portion of the work as 'especially excellent,' Dr. Eskridge simply expresses the 'fear that the new nomenclature will not meet with general favor.'

The six antagonistic reviews are con-

tained in the *Pacific Record of Medicine and Surgery*, the *London Lancet*, the *Colorado Medical Journal*, the *American Journal of Insanity*, the *New York Medical Record* and the *Journal of Nervous and Mental Disease*. I quote from the last two as highly influential and representative. The *Record* says:

"There is to be found an ample, clear and thoroughly scientific treatment of the anatomy of the nervous system. * * * We are not in thorough sympathy with nomenclatural cataclysms, and feel that frequently the old and familiar is clothed in new terms for the sake of lending an air of novelty and apparent gloss of 'science.' Still in the biological sciences nomenclature forms one of the most important landmarks of progress, especially when by it new and wider conceptions are gained. We believe, however, that in the adoption of the Wilder terminology the author has departed from a healthy historical conservatism, but this is, perhaps, an academic matter after all."

The foregoing contains so many qualifications as to leave its purport somewhat in doubt; indeed, one may imagine its writer, as he finished it, exclaiming, with the Congressman, 'Where am I at?'

The remarks of Dr. B. Sachs in the *Journal of Nervous and Mental Disease* are more explicit, and I should be glad to reproduce them in full; on the present occasion extracts must suffice:

"It is to be feared that the student will not be grateful for the introduction of the new cerebral terminology of Wilder and Gage. While recognizing the full merits of the new nomenclature and appreciating the benefits conferred upon the comparative anatomist and the comparative embryologist, the truth is, the student of neurology does not need it. * * * It has been suggested that children should begin the study of brain anatomy. The plan is a good one with reference to this nomenclature; the only way to acquire it is to acquire it early in life, when the cortical cells are ready for the reception of any and all auditory impressions. We have no doubt that in the course of time some of these names will be adopted by general consent; but it will be well along in the next century before the system, as a whole, will come into use."

Upon the whole I find myself less depressed by the objections of Dr. Sachs than

encouraged by his almost startling forecast. He is young enough for me to venture the prediction that 'well along in the next century' he will be surrounded by colleagues and pupils who, according to my plan,* commenced the practical study of the brain in the primary school, and who, by the aid of the simplified nomenclature, learned twice as rapidly as ourselves.

Among the ten favorable reviews the most elaborate is in the *Journal of the American Medical Association* (August 20, 1898). That in the *New York Medical Journal* (May 21, 1898) concludes thus:

"We are very glad that the author has had the courage to introduce these terms, believing, as we do, in their correctness and in the need of their becoming familiar."

I refrain from reading the other reviews† in Group D, mainly because the expressions therein complimentary to myself are embarrassingly numerous and emphatic. In view of this evidence those who contend that 'most scholars are repelled by my fantastic terms and defects of literary form' would seem called upon to either withdraw that claim as a misapprehension or to modify materially the commonly accepted definition of medical and scientific scholarship.

XXII. That 'barbarisms' constitute an objectionable feature of my 'system.'—Upon the supposition that by barbarisms are here meant hybrid words, this point was somewhat fully discussed in 'Neural Terms,' p. 290. Since the criticism was offered by the

* The desirability and feasibility of the acquisition of some real and accurate knowledge of the brain by precollegiate scholars. *Amer. Soc. Naturalists Records*, p. 31, 1896; *SCIENCE*, December 17, 1897.

† The *St. Louis Medical and Surgical Journal* (April, 1898); (Portland, Oregon) *Medical Sentinel* (April, 1898); (Detroit) *Medical Age* (April 11, 1898); *Canada Lancet* (May, 1898); *Richmond (Va.) Journal of Practice* (May, 1898); *Buffalo Medical Journal* (June, 1898); *University (of Pa.) Medical Magazine* (September, 1898); *North Carolina Medical Journal* (September, 1898).

chairman of the Nomenclatur Commission, Professor Kölliker, it might naturally be inferred that the list of terms adopted by that body is free from hybrid words. Yet not only does the B. N. A. contain several such, but certain of them are less euphonic than most of those for which I am responsible. Comparison is invited between the Græco-Latin combinations in the two following groups, the first from my list, the second from the B. N. A.; in each case the Greek element is printed in italics: *Metatela*, *diatela*, *paratela*, *metaplexus*, *diaplexus*, *paraplexus*, *ectocinerea*, *entocinerea*, *hemice-rebrum*, *hemiseptum*; *epidurale*, *mesovaricus*, *parumbilicales*, *parolfactorius*, *suprachorioidea*,* *pterygopalatinus*, *pterygomandibularis*, *phrenicocostalis*, *sphenopalatinum*, *sphenoc-cipitalis*, *occipitomastoidea*, *squamosomas-toidea*.

XXIII. *That progress toward the right solution of the questions involved is really facilitated by general denunciations of a given system or its advocates.*—The attitude of some may be likened to that of the child in the lines:

"I do not love thee, Dr. Fell,
The reason why I cannot tell,
But this alone I know full well,
I do not love thee, Dr. Fell."

History will record whether such conservatives shall rank with heroic defenders of law and order, or be rated among the Canutes of science, their utterances, in respect to nomenclature, remembered mainly as 'things one would rather have left unsaid.'

History will likewise record whether some others, including, of course, the framers of the 'Majority Report,' shall be metaphorically 'hanged, drawn and quartered'

* In Table IV., p. 290 of 'Neural Terms' (likewise in Biological Lectures, p. 158) *suprachorioidea* was printed without the first (and, as it seems to me, superfluous) *i*; also, most regrettably, there was included in the list *perichorioideale*, a wholly Greek combination.

as rebels, or, notwithstanding errors of judgment, credited with leaving the pathway of future students of anatomy smoother than they found it themselves.

XXIV. *That the English-speaking anatomists who have been laboring long for the simplification of nomenclature are called upon to submit indefinitely to animadversions based upon inertia, lack of information, misapprehension, or undue deference to the adverse pronunciamentos of scientific potentates abroad.*—Speaking for myself alone, the spirit in which I prefer to meet hostile criticism is fairly exemplified in my reply (*N. Y. Medical Record*, Oct. 2, 1886, 389–390) to an article in a leading medical journal containing an egregious and inexcusable misstatement that might readily have led uninformed readers to question the soundness of all my proposals. That article, however, although upon the editorial page, was evidently prepared in haste. But such extenuation will scarcely be urged in the case of the publication numbered 6 in the list in the note on p. 566. This is a review of an article (no. 5), and to avoid confusion I shall speak of the 'article' and its 'author,' of the 'review' and the 'reviewer.'

The review contains this passage:

"Some of the peculiarities of the Wilder system are then briefly discussed [in the article], attention being called to its disregard of the ordinary principles of language formation as exemplified by Ist. The mutilation of words as by using * * * *hippocamp** for *hippocampus major*."

* In the original this is 'chippocamp'. The reviewer promptly assured me that the mistake was the printer's and that it would be 'corrected wherever possible'. I assume that the copies of *SCIENCE* sent by him to others were emended like that received by me. But, so far as I am aware, no public correction has been made. Under some circumstances this might be regarded as superfluous. But it must be borne in mind that unjustifiable verbifaction constituted the very substance of the indictment; hence the situation was as if John Doe accused Richard Roe publicly of

It may be doubted whether scientific literature can furnish a single sentence of equal length containing so many erroneous statements and implications. For clear discrimination the several points shall be put in the form of questions:

1. In the article purporting to be the source of the criticism quoted is there mentioned either the word *hippocamp* or any other word representing a comparable etymologic category?

In that article, beyond the reproduction of reports including the words *hippocampus* and *hippocampus major*, the single reference is as follows (translated):

"Wilder holds that there is no longer ground for retaining *avis* with *calcar*, a term which is to be used in place of *hippocampus minor*. If this be granted, then naturally the *major* of *hippocampus major* can be dropped. The writer approves of these changes."

2. Is the reviewer himself on record as preferring the apparently alternative term, '*hippocampus major*,' to *hippocampus*?

The reviewer, as a member of our Committee on Anatomical Nomenclature, signed the first report, in 1889, which recommended the replacement of '*hippocampus major*' by *hippocampus*. Since this change was also adopted in 1895 by the Anatomische Gesellschaft, I have not supposed that its abandonment was embraced within the proposition of the 'Minority Report' that the Association should 'reconsider its acts from the beginning.'

3. Has the word *hippocamp* ever been used or proposed by me in any other status than passing counterfeit money; as if the nature of one of Roe's occupations at the time rendered it particularly desirable that his character be unimpeached; as if part of the evidence against him were a spurious coin that had been dropped into his pocket accidentally by an employee of Doe himself; and, finally, as if Doe held adequate reparation to be made by confining the admission of the mistake to the officers of the law and his personal friends. Nevertheless, in order that the issues before us may be kept free of all points upon which there may be room for diversity of opinion, this mischance shall be hereafter ignored.

that of a national, English form (Anglo-paronym) of the international, Latin *hippocampus*?

The negative answer to this may be found in various publications during the last fifteen years. Among the fuller and more accessible presentations are these passages from 'Neural Terms' (pp. 231-232, 226):

"Each anatomist prefers to employ terms belonging to his own language; at the same time he prefers that others should employ Latin terms with which he is already familiar. *Sea horse*, *Cheval marin* and *Seepferd* are synonyms (in the broader sense, §42), but to either an Englishman, a Frenchman or a German, two of them are foreign words and unacceptable. *Hippocampus* is distinctly a Latin word, and the frequent occurrence of such imparts a pedantic character to either discourse or written page. *Hippocamp*, *hippocampe*, *hippocampo*, and *Hippokamp* are as distinctly national forms of the common international antecedent (not to invoke the original Greek *ἵπποκαμπος*), and are readily recognized by all, while yet conforming to the 'genius' of each language."

4. Does the reduction of *hippocampus* to *hippocamp* represent a group of cases so numerous in even my complete list of neural terms as to constitute a prominent feature of what is called my 'system'?

The list embraces about 440 terms; besides *hippocamp* there are just two cases in which I have been apparently the first to Anglicize Latin words by dropping the last syllable, the inflected ending; viz., *myelon*, *myel*, and *encephalon*, *encephal* (and its compounds).

5. If, finally, every one of the 440 Latin terms happened to consist of a single word ending in either *a*, *ma*, *us*, *on*, *is*, *um*, or *ium*, and if I had proposed that English-speaking anatomists should customarily omit those syllables, would that render the 'system' open to the charge of 'mutilation of words' or 'disregard of the ordinary principles of language formation'?

For a negative answer to this question we need not look beyond the limits of the review itself, the language of which is pre-

sumed to be sanctioned by the authoritative journal in which it is printed. All of the following English words occurring therein differ from their Latin (or Latinized) antecedents in the omission of the inflected syllable: Form, system, barbarism, act, public, defect, subject, natural, official, distinct, historic, artificial, peculiar, human. If to these be added a few equally familiar, viz., *arm, aqueduct, oviduct, tract, exit and stomach*, it will be conceded, I trust, that *hippocamp* is in irreproachable etymologic company.

Indeed, we may now adopt the affirmative attitude and declare that among all the principles of language formation no one is better established or more generally recognized by scholars than that certain Latin words may be Anglicized by the elision of the ultima.*

I gladly forbear further direct and specific comment upon the case of *hippocamp*, but its more general aspects may be indicated in the three following queries:

1. Does scientific comity (which is comparable in some respects with what is called 'senatorial courtesy') render it incumbent upon the author of an article to refrain from disavowing responsibility for unjust statements wrongly attributed to him by a reviewer?

2. Should editorial regard for the privileges of writers tolerate the publication of unsound linguistic allegations that bring discredit upon American scholarship?

3. Is it probable that further assaults upon the simplified nomenclature from the etymologic standpoint will redound to the advancement of knowledge or the credit of the assailants?

*This is simply one of several well-known ways of converting Latin words into English; others are enumerated in 'Anatomical Terminology' (Reference Handbook of the Medical Sciences, VIII., 527); for all such processes of word-adoption the term *paronymy* (from *παρωνυμία*, the formation of one word from another by inflection or slight change) was proposed by me in 1885.

XXV. *That, saving perhaps in the case of such German anatomists as read English with difficulty, the amount and nature of the information contained in the article numbered 5 in the note to p. 566 over and above what was already accessible to them in my own publications compensates for the misapprehensions likely to be occasioned by it.*

XXVI. *That efforts toward the establishment of an international nomenclature should be abandoned because of the arrogance of individuals or committees of particular nations.—As an evidence of the existence of a real discouragement in this respect I quote from a recent private letter from a well-known naturalist:*

"I am not a believer in international coöperation, since it generally means that one nation has it all its own way."

If we read between the lines and recall the epigram, 'Man and woman are one, but the man is the one,' it may be imagined that my pessimistic correspondent adumbrates the doctrine, 'As to Anatomic Nomenclature all nations are one—but Germany is the one.'

XXVII. *That, in estimating the probability of the soundness and eventual adoption of my terminologic proposals, there should be taken into account only or even mainly the terms that are new or otherwise less acceptable, rather than those respecting which my adoption antedates that of the Anatomische Gesellschaft.—Let us grant, for the sake of argument, that my *aula, porta, cimbria, mesocolia, metatela, metaporus* and the like are doomed to 'innocuous desuetude'; shall the folly of their vain introduction outweigh the evidences of sane prevision exhibited between the years of 1880 and 1895 in the deliberate and independent choice, among abundant and perplexing synonyms, of, for example, the following: *Pallium, gyrus, fissura, insula, centralis* (rather than *Rolandi*), *collateralis, calcarina, paracentralis, praecuneus, cuneus, hippocampus, fornix, thalamus, hypophysis, di-**

encephalon, tegmentum, vermis, nodulus, flocculus, pons, lemniscus, obex, oliva, clava and vagus?

XXVIII. *That the originality of the B. N. A. (the Nomenclature adopted at Basel in 1895 by the Anatomische Gesellschaft) is to be measured by the manifestation therein of non-acquaintance with what had been proposed or accomplished by English-speaking anatomists.*—To be more explicit, I repeat here a paragraph from 'Neural Terms' (§ 276) referring to the action of American Committees between 1889 and 1892:

"Although the specific terms included in these recommendations are few, they exemplify all the commendable features of the German report. Indeed, I fail to discover in the latter any general statement, principle, rule or suggestion that had not already been set forth with at least equal accuracy, clearness and force in the writings of British and American anatomists prior to 1895."

XXIX. *That indifference or even hostility to terminologic improvement, especially upon the part of the older generation, should be thought either surprising or discouraging.*—The first point was conceded by me in 1881:

"The trained anatomist shrinks from an unfamiliar word as from an unworn boot; the trials of his own pupilage are but vaguely remembered; each day there seems more to be done, and less time in which to do it; nor is it to be expected that he will be attracted spontaneously toward the consideration that his own personal convenience and preferences, and even those of all his distinguished contemporaries, should be held of little moment as compared with the advantages which reform may insure to the vastly more numerous anatomical workers of the future."

The second point is covered by the review in the *Philadelphia Polyclinic*, which I have included in Category B (xxi.):

"While some of our friends across the Atlantic may possibly consider this too radical a departure from long-established customs, the author of the book believes that time and familiarity with the terms will justify the course he has followed."

XXX. *That action upon the general subject should be indefinitely postponed.*—This is the hour and you are the men. Let not the

'fools rush in, because the 'angels' of this Association 'fear to tread.'

XXXI. *That it is incumbent upon this Association to decide immediately upon the names for all parts of the body or even for all parts of the central nervous system.*—In a matter of such moment precipitation is to be avoided.

XXXII. *That there are contemplated by the majority of the Committee, or by any member thereof, with regard to the names of the other parts of the body, changes comparable in number and extent with what have been proposed for the central nervous system.**

XXXIII. *That members of the Association should content themselves with simply awaiting the operation of the law of the survival of the fittest.*—Upon this point I quote again the brothers Herrick. The conclusion of their article, 'Inquiries,' etc., reads:

"The unification of our nomenclature is to be accomplished, if at all, by a process of survival of the fittest among competing terms at the hands of our working anatomists rather than by legislative enactment. Yet the international discussions now in progress may do much to further this end."

I trust they will pardon me for attaching the greater significance to the final concession. The subject before us is preëminently one that concerns mind rather than matter; and its determination should be reached not so much through the operation of numbers or force as by the exercise of the highest human qualities, deliberation, self-restraint, and consideration for others.

XXXIV. *That members of this Association should defer to what is called 'general usage.'*—Of all so-called leaders, the most incapable, blundering, and dangerous is 'General Usage'. He stands for thoughtless imitation, the residuum of the ape in humanity; for senseless and indecorous fashions, the caprices of the demi-monde; for superstition and hysteria, the attributes of the mob; for

*See, for example, the report submitted and adopted at this session; *SCIENCE*, March 3, 1899, p. 321; also, *Phil. Med. Journal*, Feb. 25th, and *Jour. Comp. Neurology*, ix., No. 1.

slang, the language of the street hoodlum and of his deliberate imitator, the college 'sport'; and, finally, in science, for the larger part of the current nomenclature of the brain. As scholarly anatomists it is at once our prerogative and our duty to scrutinize and reflect, and to deal with the language of our science in the same spirit and with the same discrimination that we maintain in regard to the parts of the body and the generalizations concerning them.

It may be that a crisis has been reached; that this is the turning-point. If defeat awaits us, let there be no doubt as to my attitude. Let me be regarded as the chief offender, and let the group of terms advocated by me be derided as 'Wilder's Scientific Volapük.' But if, rather, despite errors and reverses, we are in the end to overcome inertia and prejudice, then I trust that the labors and sacrifices of so many English-speaking anatomists for the simplification of anatomic nomenclature may be recognized in the designation: 'The Anglo-American System.'

Indeed, whatever be the fate of any particular set of terms, of this I am assured: that system will ultimately prevail which is approved and used by anatomists of the English-speaking race—the composite, all-absorbing, expanding, dominating race of the future.

In no spirit of national self-glorification, much less with any personal animosity, but rather as a friendly injunction to prepare for the inevitable, I shall not object if portions of this address (for all of which, be it understood, I alone am responsible) are interpreted as a declaration of intellectual independence; as a claim for the recognition of what is done in England and America upon the basis of its intrinsic value; and as a protest against an indifference which in some instances has seemed to lack even that semblance of consideration which at least was commonly maintained during

the manifestation, a generation ago, of what an American scholar characterized as a 'certain condescension observable among foreigners.'

Let me conclude with a passage in more cheerful vein:

"When the first little wave of the rising tide comes creeping up the shore the sun derides her, and the dry sand drinks her, and her frightened sisters pull her backward, and yet again she escapes; and still her expostulating sisters cling to her skirts, and the rabble of waves behind cry out against her boldness, and all the depths of the ocean seem rising to drag her down. And now the second rank of waves, who would have died of shame at being the first, have unwillingly passed the earlier mark of the little wave that led them; and now you may float in your ship, for lo! the tide is full. So it is with all systems of reform; though the pioneers be derided, the great needs of humanity behind push on to triumphant acquisition of the new order of things."

BURT G. WILDER,

CORNELL UNIVERSITY.

*THE BREEDING OF ANIMALS AT WOODS
HOLE DURING THE MONTH OF SEP-
TEMBER, 1898.*

WITH the month of September the record of the breeding habits of the summer fauna practically closes. Very few of the species continue to breed into October. The auftrieb, though less rich in species, is at the beginning of the month similar to that of late August, but after the first week the number of forms steadily decreases. It consists for the most part of crustacean larvæ, the bulk of the material being brachyuran and eupagurid.

The temperature of the water was constant at 72° F. for the first week. It then fell steadily until the 25th, when it reached 65° F., and remained at this point until the

close of the month. The density varied from 1.0208 to 1.0225.

Vertebrata. The fishes present no features of special interest, as the summer forms are still present, and no species is breeding. The surface skimmings show a few fry at intervals. On the 20th one or two larval flatfish, in which the eyes had just begun to migrate, were taken. About the 25th three smooth dogfish, *Galeus canis*, which had been confined in the 'Pool,' were killed, and twenty-seven embryos, 10 to 11 cm. long, were found in the oviducts.

Crustacea. None of the adult brachyura examined were breeding. Zoëæ were conspicuous in the auftrieb during the early part of the month, and later various megalops were abundant.

The zoëa of *Callinectes hastatus* was the most abundant form, lasting about two weeks. The megalops of this species was plentiful at all times, particularly on the 18th. Specimens in the laboratory changed to the beautifully-spotted 'first adult' on September 27th, 29th, and October 3d. Another zoëa (which I have not identified) was very abundant in the latter part of August and the first week of September, disappearing about the 11th. It resembles the zoëa of *Callinectes*, but has a longer rostrum and dorsal spine, and the exopodite of the antenna is a straight blade as long as the rostrum.

Among the Anomura, the larvæ of *Hippa* had disappeared on September 4th. Eupagurid zoëæ swarmed in August and the first week in September, and were present in decreasing numbers throughout the month. The 'glaucothoë-stage' was abundant at all times. Data relating to the breeding of *Eupagurus bernhardus* and *E. pollicaris* are scanty, but the few females of the latter species which were examined were without eggs. *E. annulipes* was brought in on the 4th, when a few were bearing eggs in early stages of development. Females of

E. longicarpus with eggs were taken as late as the 13th.

Among the Macroura, specimens of *Virbius zostericola* had eggs in the later stages on the 11th. Larvæ and young adults, ranging in length from 5 mm. to 10 or 15 mm., were present in the skimmings. Those of small size persisted throughout the month. *Palæmonetes vulgaris* was not breeding, but the larvæ (mostly the 'fifth' and 'sixth' stages of Faxon) were occasionally taken, and toward the end of the month several of the 'first adult stage' were found. A specimen of *Orangon vulgaris* with eggs was obtained on the 19th. *Heteromysis*, dredged at Vineyard Haven on the 12th, and off Nobska Point about a week later, had well-advanced eggs in the brood-pouch.

No adult Isopoda were examined, but immature *Idotea robusta* and *I. irrorata*, ranging in length from 2 mm. upward, frequently appeared in the skimmings.

Among the Amphipoda, a minute form, apparently a species of *Montagua*, was very common among the hydroids. On September 21st nearly all were carrying eggs in various stages of development. Many *Caprellæ* obtained at the same time bore embryos approaching maturity.

Squilla larvæ (5 mm. long) appeared at intervals throughout the month. Copepods were abundant at all times. *Diastylis* was taken in the evening and is apparently attracted by any artificial light. On the 12th a number of 'Goose Barnacles' had eggs in all the later embryonic stages, and some began to liberate nauplii about this date.

Mollusca. *Scycotypus* continued to deposit its 'egg-strings' during the first two weeks of the month. The breeding period of *Crepidula fornicata* had closed, but on the 19th I found a few specimens of *Crepidula plana* with eggs in early cleavage stages. The breeding period of *Littorina littorea* in American waters is not known. On the 20th great

numbers of young, about one millimeter in diameter, were found on the rocks at Nobska Point. During the latter part of August and the early part of September, Veligers, all apparently of one species, were conspicuous in the surface skimmings; these disappeared at about the time that the young *Littorina* were found.

Vermes. Mr. R. H. Johnson found *Bugula turrita* liberating embryos, even after the middle of the month.

Small specimens of *Nereis limbata* and certain allied forms occurred sparingly in the auftrieb. On the evening of the 30th *Autolytus* was still fairly abundant, and many of the females were carrying eggs in early stages of development. *Rhynchobolus* and *Diopatra* were not breeding.

Cœlenterata. With the exception of one or two minute forms, no Medusæ were found. *Gonionemus* was abundant in the Eel Pond, and specimens brought into the laboratory about the middle of the month extruded eggs. The greater part of these eggs did not reach the blastula, and none developed beyond this stage. Ctenophores *Mnemiopsis*, very conspicuous in late August, appeared in increasing numbers during September. *Obelia*, with a few ripe gonangia, was obtained on the 21st. *Pennaria tiarella* formed the bulk of the abundant hydroid-growths on the Fish Commission wharves, although a *Eudendrium*, probably *E. ramosum*, was plentiful. Here and there small patches of *Plumularia tenella* were found. East Chop and Edgartown were visited on the 12th. At the former place there were few colonies of *Pennaria*, but a great abundance of *Eudendrium* and *Plumularia*. At Edgartown I did not find either *Pennaria* or *Eudendrium*, but *Plumularia* occurred in dense masses, which literally covered the submerged woodwork of the wharves.

At Woods Hole the colonies of *Plumularia* were small and sterile, while at the other localities they were large and provided with

gonangia in the various stages of development.

The *Eudendrium* and *Pennaria* bore medusa-buds in all stages, and the latter species remained in fruit as late as the 21st, and perhaps later.

M. T. THOMPSON.

ECONOMICS IN MANUFACTURES.

ONE of the most difficult problems in practical economics, in the whole range of modern industrial systems, is that of securing a just and satisfactory method of insuring fair exchange of labor for capital or wages where large bodies of workmen are to be employed. Cooperation and innumerable plans of 'piece-work' and 'profit-sharing' have been proposed, and none have, in practice, been found either in the abstract entirely equitable or wholly satisfactory to the employer as securing sufficient output from his always burdensome investments, profit on his sales, or a contented and fair-minded relation between himself and his employés; nor has any system been found which fully satisfies the workman in either extent of total compensation, opportunity to secure compensation proportioned to his exertions and ability, or in abstract equity in distribution of profits.

One of the most promising of the later plans for a fair and honest and satisfactory distribution of profits and a very effective stimulus of the right spirit in both employer and employé was described, as a first experiment, to the American Society of Mechanical Engineers, some years ago, by Mr. F. A. Halsey, then or earlier manager of the Canadian Rand Drill Co., at Sherbrooke, Quebec, Canada. Mr. Halsey called his plan 'The Premium Plan of Paying for Labor,' and the title is indicative of its nature.*

The author of this system now reports the outcome of a considerable number of

* Trans. Am. Soc. Mech. Eng'rs; Vol. XII.

experiments in its employment, some by important and famous manufacturers of various mechanical devices, from the steam-engine to the machine-tool. The following abstract is based upon his account of these later experiences, as given in the *American Machinist*, with extended tables of data and results.*

The plan has been in use eight years, and has come into use, in a number of establishments, sufficiently to give ample experience in its workings. Curiously enough, however, although devised for the benefit of the workmen, mainly and primarily, and invariably promising them gain, it has as invariably been received with suspicion and reluctance by them, and in at least one case has been opposed by the trade-unions of the place. In all but a single case, however, it has proved entirely successful in the accomplishment of its purpose—the promotion of the wage-earning power of the men and of the dividend-paying power of the establishment; sharing profits while stimulating ambition and increasing output. It gives the workman increased day's wages; it gives the employer increased output from his works, at reduced cost and increasing profits, shared with those who make them possible. The workman gains directly, day by day; the employer not only gains, directly, by increased output from the same number of men, but also indirectly and in an exceedingly important degree, often, through the increased earning power of his capital, invested in plant and in funds.

Piece-work has not been wholly successful, and in too many cases the selfishness and greed of the employer, seeking to monopolize all the profit, compels the workman to accept a rate which makes his day's work no more profitable to him when working under high-pressure than when doing an ordinary day's work at fixed wages at such a rate that he can sustain that amount

of production indefinitely. Where properly adopted and adjusted, it is a vast improvement upon the older plan. Mr. Halsey's plan puts a premium upon increasing production, in such manner that both employer and employé are inevitably alike advantaged, and skill and industry and steady work secure proportional reward. It involves something of the principle of the common bargain by which a salesman is given a fixed and moderate salary *plus* a stated percentage on sales. Under this new plan the employer offers a workman a premium, perhaps ten cents, for each hour by which the production of a certain piece is reduced below that of the observed normal average or below an assumed period of time; the day's wage being that of the time and place, as fixed by ordinary circumstances in the market, and without control, usually, by either party to the bargain.

Suppose that pay to be three dollars a day and an hour to be saved in a piece ordinarily requiring just a day's work for its production. The proprietor gains the hour and his thirty cents otherwise paid as wages for the hour; he loses ten cents premium; he gains in rate of output of the establishment, and so makes it possible to secure larger returns through more effective use of all other capital than the 'wages fund'. The workman gains his ten cents and the privilege of adding an extra hour's work on a new 'job.' Thus both parties gain. Had the premium been fifteen cents the money-gain would have netted both equal amounts, fifteen cents, per day. Thus, as in Table I., we sometimes actually find enormous gains possible through the ingenuity of the workman in finding ways of reducing time of production, as by increased personal activity, or by securing deeper cuts and higher speed of cutting, or less time in putting the piece in place or in replacing it by its successor, etc. The writer has known of a case in which the

* March 9, 1899.

ter for the employer to be liberal in estimating the time-rate rather than with the premium-rate. Excessive premium-rates are apt to result in too large expectations to be fully met in the long run. From one-half to one-third the saving are usual premium-rates, and probably one-third to the workman and two-thirds to the firm best brings out a permanent and satisfactory adjustment which, if found inequitable, can generally be easily readjusted to a correct figure. In one machine-tool works the premium-rate is thirty-six per cent. and is found satisfactory to both sides. The higher premium-rates, however, should be paid for manual labor, as in blacksmithing, and the lower to power-tool work, as at the lathe or the planer or the milling machine. Undoubtedly every establishment, and every department of labor, from floor-sweeping to book-keeping, has its own peculiar best rate. In all cases the result may be expected to be a largely increased output of the works, a greatly increased earning power on the part of the men, and decreased costs of production with increased dividend-paying power for the holders of the capital. "Wisely administered, the plan will do more to settle the wages-question than anything else that has been suggested," and the wages-question is to-day the burning question in the economics of manufacturing.

R. H. THURSTON.

SCIENTIFIC BOOKS.

Analytic Functions. Introduction to the Theory of Analytic Functions. By J. HARKNESS and F. MORLEY. London, Macmillan & Co. 1898. 8vo. Pp. xvi + 336.

The appearance of the present work is a very pleasant sign to friends of the modern school of mathematics in England and America. It indicates that the movement which set in some years past with us in this direction has been steadily growing; that the theory of functions is no longer the property of a few bold and rest-

less minds, but has already descended to the masses. The present work may very happily serve as a text or reference book to a first course on the theory of functions in the senior class of any of our better universities. The theory of functions of a complex variable may be viewed from two standpoints. One was taken by Cauchy and Riemann; the other by Weierstrass. The methods of Cauchy and Riemann are more natural and intuitive; those of Weierstrass more abstract and lend themselves more easily to a rigorous treatment of the subject. The authors have chosen the methods of Weierstrass.

Roughly speaking, the subjects treated in the first 100 pages fall under two heads:

1. The geometric representation of complex numbers, the conformal representation afforded by

$$y = \frac{ax + b}{cx + d}$$

and the first properties of rational functions.

2. Topics which lie at the foundation of the calculus.

The treatment of the first group of subjects is admirable. In regard to the second it seems to us that the authors have attempted the impossible. The theory of function in common with the calculus rests on certain notions, such as that of number, limit, continuity, extremes of functions, etc. These subjects are very imperfectly treated in English works on the calculus, and our authors have thus found it advisable to give some account of them in the present volume. The amount of space at their disposal was very limited, and they have, therefore, been obliged to be excessively concise. This has been carried to such an extent in the chapter on number, Chapter I., that the subject, so it seems to us, will be utterly incomprehensible to the student.

We cannot understand why, if it is worth while to say anything about irrational numbers, the arithmetical operations upon them are passed over in absolute silence. Until the terms sum, product, etc., are defined they have no meaning.

Chapter VI., which treats of limits and continuity, suffers severely on account of the brevity of Chapter I. In this chapter it is important to establish the existence of certain

numbers. The arguments cannot have much meaning to the student until the material of Chapter I. has been grasped, and this seems out of the question.

Before leaving this section we call attention to a curious break. On page 48 complex functions of a real variable are differentiated and integrated. This certainly is illogical until such operations have been defined. We are tempted to believe that the beauties of this chapter will fall very flat with the average student. If the geometrical theory of the logarithm is to appeal to him, what is stated here so rapidly should be given with leisure and detail.

The next 60 pages, Chapters VIII.-XII., deal with infinite series, and so lead us to Weierstrass's conception of analytic functions. This, as is known, depends on infinite series ascending according to integral powers of $(x-a)$. The treatment here is very superior—the authors show a masterly grasp of the subject. A short chapter on the analytic theory of the exponential and logarithmic function now follows.

Chapters XIV. and XV., pp. 178-209, turn again to the general theory. Singular points are discussed, and Weierstrass's decomposition of a function into prime factors is deduced. Application is made to show that

$$\sin \pi x = \pi x \prod (1 - x^2/n^2). \quad n = 1, 2, \dots, \infty.$$

The consideration of the zeros gives at once

$$\sin \pi x = x e^{O(x)} \prod (1 - x^2/n^2).$$

The determination of the integral transcendental function G is singularly difficult. It seems a pity that the method invented for Cauchy for the same purpose and which may easily be made rigorous is to-day quite neglected. By this method G is readily found.

With Chapter XVI., which treats of integration, we arrive at the starting point of the Cauchy-Riemann theory. It seems to us that our authors have not maintained the high ideals here as well as elsewhere. In a passage, pp. 11, 12, we read: "But in using geometric intuitions * * * we must emphasize one lesson of experience; that the intuitional method is not in itself sufficient for the superstructure. It has been found that only by the notion of number * * * can fundamental prob-

lems be solved. If, however, we are prepared to replace when occasion arises these geometric intuitions * * * then and only then is the use of geometry thoroughly available." It is true that the authors *here* speak of points, distances and angle only, but these remarks apply with equal cogency, as they will be the first to admit, to all geometric intuitions when used in analysis. We are, therefore, surprised to find the obscure notion of curve, of its length, of a closed curve, of a region, etc., freely used without any attempt to put them on a number basis. Such statements as that on p. 189, viz.: that a circuit divides the entire plane into two regions will certainly embarrass the authors to prove in its generality. Again, on p. 218, we see the authors implicitly define the length of a curve C to be $\int_C |dx|$. This definition differs from the one given our text-books, viz.: $\int dx \sqrt{1 + f'(x)^2}$. As our authors propose to use a broader definition than usual, it seems only fair that they state this to the reader. Still a more serious objection is to be urged to their procedure. It results in stating Cauchy's fundamental theorem and other important theorems of this chapter without any restriction regarding the path of integration. This seems to us like talking of infinite series without bothering ourselves about convergence.

Chapter XVII. brings a brief discussion of Laurent's and Fourier's series. Then follow two excellent chapters on the elliptic functions. These are followed by two chapters or about 30 pages devoted to Algebraic functions and Riemann surfaces.

It appears to us that the fictitious number and point ∞ has been treated too hurriedly. These notions are very important and also difficult for the student to master. Our authors have followed the usual custom of disposing of them with a few words here and there. We believe the custom of introducing the number ∞ is bad. The theory of functions of a complex variable is a theory of two very special real functions of two real variables. In the theory of functions of real variables the number ∞ does not exist. It seems to us that its introduction can only produce confusion and embarrassment.

It is not a number ∞ we are ever concerned with. When we say $w(a) = \infty$ we really mean $\lim |w(z)| = \infty, z = a$. Again when we ask how does $w(z)$ behave for $z = \infty$ we really mean how does $w(1/\zeta)$ behave in the vicinity of $\zeta = 0$ where $\zeta = 1/z$. Thereby ζ is never required to assume the value of 0 . On using the sphere instead of the plane we get the punktierte Kugel. The missing point we can supply or not at our option. In any case no number shall correspond to it. We firmly believe that the easy intuitional way of treating ∞ in the function theory of a complex variable must be modified as here indicated.

The last chapter is devoted to a brief *aperçu* of the function theory from the standpoint of Cauchy and Riemann. We cannot appreciate the difficulties mentioned in § 164 as underlying the definition of a function from the Cauchy-Riemann standpoint. They seem to us to be due to the belief on the part of the authors that we must take the whole z -plane into our definition from this point of view. Such is not the case. As a domain D for the variable z we take any point multiplicity consisting only of interior points. If it be possible to pass from any point of D to any other of it along a continuous curve $x = \phi(t), y = \psi(t)$ we say D is a simple domain. Otherwise D is composed of simple domains $D = D_1 + D_2 + \dots$. To get a synectic function $w(z)$ for D we take two single valued functions $u(x, y), v(x, y)$ defined over D and such that for every point in D they have a total differential and satisfy the equation.

$$\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y} \quad \frac{\partial u}{\partial y} = -\frac{\partial v}{\partial x}$$

In any one of these simple regions as R_α , $w(z)$ can be developed into an integral positive power series. The analytic function $f(z)$ obtained from one of these elements is identical with $w(z)$. There certainly is no reason to suppose that $f(z)$ when continued into another region R_β should be identical with $w(z)$ in this region. This seems to answer all the objections in I and II of this article. Indeed, the advantage seems to be decidedly on the side of Cauchy, for exactly one of the points urged against Cauchy's theory is now without force, while it is, indeed, an important matter from Weierstrass'

standpoint. This, in the author's words, is: "That Cauchy's definition implies in various ways a considerable preliminary grasp of the logical possibilities attached to the study of singular points." From our standpoint we fix in advance the domain D ; it has no more singular points than we choose to assign. Not so with the analytic function. Here an element is given, one singular point must lie on its circle of convergence. Where the others are is a subject of further study.

We cannot see the difficulty mentioned under III. It is, indeed, an interesting matter to know 'the irreducible minimum of conditions to impose on $w(z)$,' but it seems to us nowise necessary. It suffices that we know the necessary and sufficient conditions in order that $w(z)$ can be developed according to Taylor's Theorem. This we know and we have taken them into our definition of $w(z)$. It may be interesting to remark, however, that these conditions are already known, as will appear in a remarkable paper of E. Goursat shortly to be published.

We close, congratulating the authors for writing a work which we believe will prove an excellent aid to acquire some of the essentials of the theory of function. We should have preferred to see the two theories of Cauchy and Weierstrass blended together into an organic and indivisible whole. Although these two theories grew up quite distinct, they have already been welded into one greater and more powerful theory. It is only the purist who still tenaciously clings to the methods of Weierstrass. It seems, therefore, very desirable to us that an introductory work should be written more in accordance with this fact.

JAMES PIERPONT.

YALE UNIVERSITY, March, 1899.

A Handbook of Metallurgy. By DR. CARL SCHNABEL. Translated by HENRY LOUIS. New York, The Macmillan Company. Two volumes, medium 8vo. Total pages, 1608. Illustrated. Volume 1, copper, lead, silver, gold. Volume 2, zinc, cadmium, mercury, bismuth, tin, antimony, arsenic, nickel, cobalt, platinum, aluminum. Price, \$10.00.

The author states in the preface that, while many exhaustive works have appeared on the

metallurgy of individual metals, the few books on general metallurgy were arranged as text-books and made no pretence of thoroughness of detail or treatment. With these facts in mind the present work was compiled, with the stated object of giving a complete account of the metallurgical treatment of every one of the metals ordinarily employed, together with the recent improvements in the art, stating the underlying scientific principles and illustrating by actual practice.

This object is highly commendable, but the statement is rather misleading, as iron and steel have been entirely omitted and no mention made of the omission or of a subsequent volume upon this all-important branch of metallurgy. This fact should have been stated plainly by the author in the preface and by the publisher in the advertisements.

Dr. Percy's historic work was selected as the basis, and on this are grouped many facts from the works of modern writers, notably Hofman, on lead; Peters, on copper; Egleston, on gold and silver, and Borchers on electro-metallurgy. The work is quite exhaustive in character, as the grand total of 1608 pages indicates, but, unfortunately, the exhaustion is not limited to the subject-matter of the book and oftentimes extends to the reader, as much of the material is vague and unnecessarily verbose. The work lacks that clearness of description, lucidity of arrangement and conciseness of statement so needful in the treatment of a large subject and so appreciated by American readers with whom time is an object.

It is to be regretted that much ancient material is perpetuated in excruciating detail, particularly as it is so interwoven with modern practice that the general reader is left in doubt what is in use at the present time. To illustrate this, under the chapter on silver, barrel amalgamation is quoted as now in use at the Pelican Mill, Georgetown, Colo., while, as a matter of fact, it was there abandoned twenty years ago. Another instance, under the chapter on zinc, the furnace used in the old English process—that rare bird of antiquity—shows forth resplendent in full detailed illustration. As to this furnace, Dr. Percy, in 1869, failed to find even the ruins of its foundation.

The large amount of material collected in these two volumes contains much of value to the specialist, but it is too encyclopedic in character to be of any marked assistance to the general reader. Its main value is for reference in a scientific or technical library.

A few minor errors, such as the location of Boston in Vermont (Vol. 1, p. 115) and Orford in New Jersey (Vol. 2, p. 104), may be overlooked in a work of this large size.

The criticism of this work may be considered harsh, but the eminent position occupied by Dr. Schnabel leads one to expect the highest standard of work and to be disappointed if it is not attained.

J. STRUTHERS

BOOKS RECEIVED.

Organic Chemistry. Edited by R. ANSCHÜTZ. Authorized translation by EDGAR F. SMITH. Vol. I., Chemistry of the Aliphatic Series. Philadelphia. P. Blakiston's Son & Co. 1899. Pp. xviii + 625. \$3.00.

Commercial Organic Analysis. ALFRED H. ALLEN, Philadelphia, P. Blakiston's Son & Co. 1899. Vol. II., Part I. Pp. x + 337. \$3.50.

The Spirit of Organic Chemistry. ARTHUR LACHMAN. With an introduction by PAUL C. FREER. New York, The Macmillan Company. 1899. Pp. xviii + 299. \$1.50.

The Arithmetic of Chemistry. JOHN WADDELL. New York and London, The Macmillan Company. 1899. Pp. viii + 133. 90 cents.

Allgemeine Erdkunde. J. HANN, ED. BRÜCKNER and A. KIECHHOFF. III., Abteilung Pflanzen- und Tierverbreitung. ALFRED KIECHHOFF. Prague. Wien und Leipzig, F. Tempky. 1899. Pp. xi + 327.

SCIENTIFIC JOURNALS AND ARTICLES.

The Botanical Gazette for March contains the following papers: D. H. Campbell: 'Notes on the structure of the embryo-sac in *Sparganium* and *Lysichiton*,' pp. 153-166, with one plate. This is a continuation of the author's studies of the primitive monocotyledons. The discovery of special interest is the extraordinary development of the antipodal cells in *Sparganium*, another evidence of the variable nature of the antipodal region. H. C. Cowles: 'The ecological relations of the vegetation on the sand

dunes of Lake Michigan,' pp. 167-202, with eight photographs. This very complete ecological study of the dune floras is continued from the February number. A special feature of this part is the discussion of embryonic dunes. The active or wandering dunes are also taken up and will be completed in a subsequent number. The following briefer articles appear: Ralph E. Smith: 'A new *Colletotrichum* disease of the Pansy;'; E. J. Hill: 'A new biennial-fruited oak,' with two plates; Elias Nelson: 'The Wyoming species of *Antennaria*,' in which eight new species are described. Numerous Book Reviews and Notes for Students complete the number.

SOCIETIES AND ACADEMIES.

ANTHROPOLOGICAL SOCIETY OF WASHINGTON.

THE 289th regular meeting of the Anthropological Society was held Tuesday, March 28, 1899. Dr. J. Walter Fewkes made a communication on the 'Winter Solstice Altars at Hano,' a Tewan pueblo in Tusayan. He began by saying that the Territory of Arizona is covered with mounds or ruins indicative of the habitations of prehistoric pueblo people, but that it is evident that these villages were never simultaneously inhabited. Their distribution shows that this agricultural, aboriginal population of Arizona was more evenly distributed over the Territory in ancient times than at present. The presence of nomadic enemies—Utes, Apaches, Navajos and others—had led to a concentration of the pueblo aborigines of this region into limited areas, a movement which began in the 15th century and was continued in the two following. The so-called province of Tusayan was one of those centers of concentration or refuge, and the inhabited pueblos of the area now contain some of the descendants of the survivors of the abandoned villages between the Mojollones Mountains and the Utah boundary.

Three of these Tusayan pueblo—called Walpi, Siteomori and Hano—are situated on one mesa, not more than a gunshot apart. Dr. Fewkes showed how Walpi had been founded by clans driven southward from the Colorado River, and how their pueblo had grown by successive incoming clans from south and east. At the end of the 17th century the hostile nomads had so

closed in on Walpi that they swarmed in their farms, and utter annihilation stared the Hopi in the face. The Governor of Walpi sent to New Mexico for help, and after four appeals a band of Tewa warriors from a pueblo in the upper Rio Grande valley went to his aid. These warriors drove back the Utes, and in return for this help, the Tewa were given a site for their home near the main trail to the mesa upon which Walpi is situated. The village which they built is now called Hano. For two centuries the successive generations of inhabitants of Hano have remained Tewan in their customs in the country of their adoption. Hano preserves the Tewan language, although, by marriage with the neighboring Hopi, the consanguinity of the inhabitants is more Hopi than Tewa. Similarity of language is not always a sign of blood kinship. There are also many Tewan customs in marriage, mortuary and other rites in Hano, but the most characteristic of all are the religious festivals. The most instructive of these are the winter-solstice rites.

Of all expressions of religious sentiment objects like fetishes and ceremonial paraphernalia are the least variable from generation to generation. Mythology changes as man advances in culture or lives in a new environment, and accretions in form of myths to adjust worship to the spirit of the times multiply from generation to generation. Expression of the religious feeling through acts or dramas called ceremonies is more conservative than through myth and less modified by the evolution of culture, and new myths are invented to harmonize and explain ceremonies handed down from ancient times. The objects used in worship—fetishes, idols, paraphernalia—change even less than rites or myths, and reflect better than both the true ancient religious sentiment of which they are expressions, and are, therefore, of preeminent importance to the ethnologist in the study of ethnographic religion.

These ceremonial objects are very numerous among the Hopi; and their installation in sacred rooms, at times of great ceremonies, is called an altar. The two altars at Hano during winter-solstice rites were described in detail. The most striking fetishes upon them were clay images of the Great Snake. There were also

rain-cloud symbols, gaming implements, water-worn stones, puma paws and other objects. The imitation of an ancient ladder which stood back of the altar was called a sun-ladder, and was interpreted as a symbolic aid to the sun, who is supposed to be weary at the winter solstice. Through sympathetic magic he is thus supposed to gain strength to mount the sky from his home at sunrise.

These altars at the winter-solstice ceremony in Hano made it possible to know something of the character of the ancient Tewan Sun and Snake worship, of which little has yet been recorded, although this pueblo stock has been, and still remains, one of the most important in the upper Rio Grande pueblos. Possibly studies of secret rites in the estufas of the latter will bring to light the characteristics of their winter-solstice altars, but it is also possible that these altars have been abandoned, in which case the survivals at Hano, described by Dr. Fewkes, have value in a comparative way, as indicating the nature of Tewan altars in mid-winter.

Mrs. Olive Ennis Hite presented a paper on 'New Mexican Folk-Lore,' in which she described the environment of these people and showed the influence it had upon their superstitions. Their belief in the 'Hombrecito,' or little brown people, was widespread, and it was considered lucky to see one of these creatures, who were visible to the 'pastores,' or shepherds, only. Of 'las brujas,' the witches, there is less said, and that little with many 'carambas' and audible supplications for the intervention of 'la Santissima Maria.'

Discussed by Drs. McCormick, Fewkes and Kober, Professor McGee, Dr. Wilson, Mr. Pierce and Miss Alice C. Fletcher.

J. H. MCCORMICK,
Secretary.

GEOLOGICAL CONFERENCE AND STUDENTS' GEOLOGICAL CLUB OF HARVARD UNIVERSITY.

Students' Geological Club, March 14, 1899. Mr. A. W. Grabau reviewed the paper which Professor Shaler has recently published on the Geology of Cape Cod (18th Annual Rep., U. S. Geol. Surv.). The speaker did not agree with the view advocated by Professor Shaler, that the topography of lower Cape Cod, from

Orleans to Highland Light, is mainly erosional and scarcely modified by ice action. But he held that the orientation of the valleys, the character of the slopes, and the presence of typical kettles all over the cape, indicate that most of the material of Cape Cod is of glacial origin.

Geological Conference, March 21, 1899. Mr. F. M. Buckland gave a paper on 'Winter Changes about Fresh Pond.' After briefly reviewing the literature on the expansion and contraction of ice on water bodies, he described some of the effects of these agencies on the shore of Fresh Pond during the past winter.

Mr. J. B. Woodworth presented some results of field observations on 'Moen's Cliff and the Maars of the Eifel.' The Cretaceous and Pleistocene beds of the island of Rügen, off the coast of Germany, and Moen, off the coast of Denmark, show a disturbance which is comparable in degree and character to that in the Cretaceous and Pleistocene of Martha's Vineyard. H. Credner attributes this deformation to the shoving action of an ice sheet which was immediately previous to the last. A few other geologists favor purely orogenic agencies. In neither case has conclusive physical evidence been found. The lantern views, which are recent accessions to the Gardiner Collection, illustrated this deformation and related features, and the Weinfelder and Gemündener Maars near Daun.

J. M. BOUTWELL,
Recording Secretary.

TORREY BOTANICAL CLUB, FEBRUARY 28, 1899.

PROFESSOR L. M. UNDERWOOD presented a paper on 'Species confused under the name *Aspidium juglandifolium*,' discussing the characters and geographical distribution of the forms regarded by him as distinct species, eight in all, constituting the whole number attributed to the genus *Phanerophlebia*. He remarked in concluding that it would be unsafe to describe new species without consulting the valuable collections of ferns in Europe, and especially at Kew. The paper will appear in the *Bulletin*.

Miss Alice Lounsbury then exhibited the very valuable collections of flower paintings by Mrs. Ellis Rowan, which constitute the origi-

nals of the colored plates in Miss Lounsberry's forthcoming work, 'How to Know the Wild Flowers.' Selections which showed the character of the book were read, including the Introduction, written by Dr. Britton, and the Preface, which pointed out the fact that the distribution of plants according to soils was made the keynote of the work.

Dr. Britton said that the book was interesting to him on two accounts, from the ecological basis of classification and the remarkable reproductions in color.

In the absence of Mrs. Annie Morrill Smith, of Brooklyn, Mrs. E. G. Britton read for her the manuscript of a paper, entitled 'The Flora of the Adirondack Mountain Club Area.'

Meeting of March 14, 1899.—The Summer Courses in Botany given jointly by this Club and the College of Pharmacy were announced to begin at 4:30, March 24th, ending June 10th, the General Course to be given by Dr. H. H. Rusby, that in Histology by Dr. M. A. Howe.

The paper of the evening, by Mrs. Caroline A. Creevey, on 'Plant Juices and their Commercial Values,' described the secretions, oils, gums, resins and other products of plants, with exhibition of numerous specimens. Among the numerous oils considered none has become so important commercially as cotton-seed oil, now produced at about 28 million gallons per year, pressed from 800,000 tons of cotton seed. Another industry dependent upon plant juices is that of tanning, the tannin found in the saw-palmetto and in *Rumex hymenosepalus* promising to revolutionize the process of the leather-industry. The waste sands occupied by these plants in the South and West bid fair to become valuable.

Dr. Underwood exhibited a series of photographs of the Fleshy Fungi by Mr. G. A. Anderson, of Lambertville, N. J., colored from the living specimens by his daughter, Miss H. C. Anderson. They illustrate a new process of preserving fleshy fungi.

Dr. Britton reported a brief communication from Mr. A. A. Heller sent from Porto Rico, February 18th, reporting collections made about Ponce, Ibonito, Coamo, etc., now reaching 584 numbers after six weeks' work. On the north side of the islands many species occur on the

shore which are montane species when growing on the south side.

Dr. Britton also read from a letter of February 26th, just received from Mr. S. Henshaw, from San Juan, describing the sugar plantations, now in the midst of cutting and boiling. He finds the flora not so varied as in Trinidad; the woods are few; in 100 miles he did not see a single large tree.

EDWARD S. BURGESS,
Secretary.

DISCUSSION AND CORRESPONDENCE.

DUPLICATION OF GEOLOGIC FORMATION NAMES.

REFERRING to Mr. F. B. Weeks' letter on this subject in your issue of March 13th, I venture to doubt whether Cache Valley group (1879) or Cache Lake beds (1888) can properly be considered as conflicting with each other or with the name Cache Creek formation. If, however, regarded as an undesirable duplication of similar names, I wish to point out that the Cache Creek group or formation undoubtedly holds priority, a circumstance which would scarcely appear from Mr. Weeks' remarks.

The name was first applied (by Dr. Selwyn, in 1872) as Upper and Lower Cache Creek groups, to certain rocks in British Columbia. The age of the upper series was only conjectured, but the lower was known to occupy a position somewhere 'between the base of the Devonian and the summit of the Permian.' In 1876 Carboniferous fossils were found in rocks assigned to the lower group in the northern part of British Columbia, and in the following year a re-examination of the original area led to the discovery of similar fossils in both lower and upper groups there. In my report for 1877 these groups are, therefore, referred to collectively as the Cache Creek series. In the latest report dealing with these rocks the same usage is followed, although upper and lower parts of the Cache Creek series or formation are separately referred to.

It thus appears that the name in question has been consistently applied by the Geological Survey of Canada to the same terrane since 1873. Nor is it merely a 'horizon' of the Carboniferous, but a formation estimated at more than 9,000 feet in thickness. It includes, in

fact, the Carboniferous formation in so far as this has been recognized in the interior district of British Columbia, and is the local representative of that formation.

GEORGE M. DAWSON.

GEOLOGICAL SURVEY OF CANADA,
April 10, 1899.

ON THE NAMES OF CERTAIN NORTH AMERICAN
FOSSIL VERTEBRATES.

THE writer, having recently had occasion to examine the literature pertaining to some of the fossil mammals of North America, has made the following notes, which he desires to record:

Hemiganus, a genus established by Professor Cope, had for its type species *H. vultuosus*. The species *H. otariidens* was described later. Dr. J. L. Wortman has, however, shown (Bull. Amer. Mus. Nat. Hist., ix., p. 167) that *H. vultuosus* is a synonym of *Psittacotherium multifragum*. The species *otariidens* is, therefore, left without generic name. I hereby propose WORTMANIA, in recognition of the valuable work which has been done by Dr. Wortman in vertebrate paleontology. The species will be *Wortmania otariidens* (Cope).

A similar case occurs among the camels. The type of the genus *Protolabis* of Cope is *P. heterodontus*. Dr. Wortman's investigation (Bull. Amer. Mus., x., p. 120) have led him to the conclusion that this so-called species is the same as the earlier described *Procamelus robustus*. The type species being removed, the remaining species requires a new generic name. I propose MIOLABIS. The type will be *M. transmontanus* (Cope).

It has also been ascertained by Dr. Wortman that the type of the genus *Systemodon*, *S. tapirinus*, is really a *Hyracotherium*, in which genus it was formerly placed. The species which have been associated with *tapirinus*, viz, *semihiana*, *primævus* and *protapirinus* are, therefore, without generic name. I offer HOMOGALAX (*ὁμογάλαξ*, a foster brother). As type of this genus I take Dr. Wortman's *Systemodon primævus* (Bull. Amer. Mus., viii., p. 89, fig. 3).

Professor Cope has described from the Pliocene of Louisiana a fossil horse which he calls *Equus intermedius* (Proc. Amer. Phil. Soc., xxxiv., p.

463). This name has, however, been preoccupied for a quaternary horse of Europe. Trouessart (Cat. Mam., 1898, p. 794) quotes it as a synonym of *E. caballus*. The first mention I find of the name is in Rütimeyer (Abhandl. schweiz. pal. Ges., ii., p. 24, 1877). For Professor Cope's *E. intermedius* I propose *Equus eous*.

Interea volucres Pyrois *Eous* et Aethon,
Solis equi, quartusque Phlegon, hinnitibus auras
Flammiferis implent, pedibusque repagula pulsan.
—Ovid.

Certain generic names of vertebrates have, without justice, it seems to me, been relegated to synonymy.

In 1881 Professor Cope established a genus of Condylarthra which he called *Protoponia*. Later he correctly concluded that this name had been preoccupied, probably by *Protoponia*, Hübner. He, therefore, proposed to substitute for it *Euprotogonia*, which name first appeared in a paper by Earle (Amer. Nat., 1898, p. 378, foot-note). In a recent paper Dr. Matthew (Bull. Amer. Mus., ix., p. 303) accepts this name. At the same time he shows that those remains which had originally been described by Professor Cope as *Miocænus flowerianus* belong to the earlier described *Euprotogonia puercensis*. But, for this *M. flowerianus*, Scott had in 1892 (Proc. Acad. Sci., Phila., p. 299) proposed the genus *Tetracænodon*. The latter name, therefore, antedates *Euprotogonia* and must replace it.

In the same excellent paper (p. 268) Dr. Matthew adopts Scott's genus *Protochriacus*, founded in 1892, in preference to Cope's *Loxolophus*, proposed in 1885. The reason assigned for this preference is that Professor Cope's 'distinctions, so far as made, were based on error.' I do not believe that the best usage among naturalists at this day favors the rejection of generic names because of errors, real or supposed, in the definitions. It seems to me that *Loxolophus* must be reinstated.

With exceptions, few but important, *Oreodon* has been employed by writers for a well-known genus of Artiodactyles. Flower and Lydekker in their joint work on Mammalia use *Cotylops*, on the assumption that *Oreodon* is preoccupied by *Orodus* of Agassiz, a genus of fossil fishes. Without now discussing this conclusion, I will

recall the fact that there is a still older name which is in all respects available. This is Leidy's *Merycoidodon*, having for its type *M. culbertsoni* (Proc. Acad. Sci., Phila., 1848, p. 47). Professor Cope has rejected the name on the ground that it is a *nomen nudum*; but a generic name is hardly *nudum* when it is supported by a well-defined species and is, moreover, clothed with two pages of description.

Merycodus is another of Dr. Leidy's names which must be restored to its rightful position. This was proposed in 1854 and had for its type species *M. necatus*. On the supposition probably that this name is pre-occupied by Owen's *Merycodon*, it has been ignored. But it is incorrect to assume that any two names ending in *odus* and *odon*, but alike in other respects, clash with each other. As to their forms they are different enough to prevent confusion. As to their derivation, as has been suggested to me by my friend Dr. Leonhard Stejneger, of the U. S. National Museum, they are unlike; *odus* being the Latinized form of the Greek *ὄδος*, while *odon* comes from the Ionic *ὄων*. The acceptance of this view will relieve us of the necessity of rejecting, on philological grounds at least, either word of many such couples as *Menodus* and *Menodon*, *Cosmodus* and *Cosmodon*.

O. P. HAY.

THE FUNDAMENTAL LAW OF TEMPERATURE FOR GASEOUS CELESTIAL BODIES.

It has been long known that an isolated celestial mass of gas rises in temperature as it radiates heat and contracts. Dr. T. J. J. See [*Astronomical Journal*, February 6, 1899; *Atlantic Monthly*, April, 1899] points out that the temperature of such a mass of gas is inversely proportional to its radius, provided the mass does not receive accretions of meteoric matter and provided the gas conforms to the laws of Boyle and Charles. When, however, the volume of the gaseous body is very great large quantities of interstellar gases and particles would fall into it and the first condition would fail; and when the gaseous body contracts to small volume it would, perhaps, be far from a perfect gas in its properties, so that the second condition would fail; to say nothing of the probable dissociation and polymerization of the

gaseous constituents due to the great changes of temperature which, no doubt, take place.

The suggestion of Dr. See that nebulous masses are extremely cold is very plausible, in view of his 'new law,' which 'may be assumed to regulate the temperature of every gaseous star in space,' but it is certainly contrary to the indications of the spectroscope; for nebulae surely are approximately in thermodynamic equilibrium in their smaller parts, if anything in the universe is; if so, there is no known agency, electrical or other, which can cause them to give off persistently abnormal radiations. Radiations (wave-length) are as intimately associated with temperature as are molecular velocities, although both may be temporarily abnormal in a given substance; for example, the velocities of the particles of a gas in a vessel may be made to deviate momentarily from Maxwell's law; a cold substance, such as calcium sulphide, may shine for a while after exposure to sunlight, and a gas in a vacuum tube may remain phosphorescent for a time as the disturbing influence of an electric discharge dies away. But it is hard to think of a certain cubic foot of nebulous matter, surrounded for millions upon millions of miles with similar matter, remote from intense radiant centers, still giving off abnormal radiations after odd millions of years. Of course, such may be the case, but Dr. See's law, in all probability, has nothing to do with nebulae at all. There is no physical reason why a nebulous mass might not be intensely hot, held together (if, indeed, we must assume it to be a gravitational unit) by the gravitation of refractory nuclei and receiving continually from space as much matter as it throws off, because of the high molecular velocity of its gaseous parts.

Dr. See's derivation of his law of temperature is incomplete and confused. It is based upon the assumption, which should be definitely proven, that the function which expresses the density in terms of the radius coordinate r remains of the same form as the external radius ρ diminishes; and he confuses *pressure per unit surface* and *pressure between given portions of matter*. Assuming the invariance of the density function Dr. See's formula may be derived as follows. Let ρ be the radius of the gaseous

mass at a given epoch. Consider the state of affairs when the radius has become $\frac{1}{2} \rho$. Gravitational forces (per unit mass) will be quadrupled and, therefore, the pressure between two contiguous portions of given mass will be quadrupled, but the area separating these portions will be quartered so that the pressure per unit area (p) will be 16 times as great. The volume v of each portion will be $\frac{1}{8}$ as great, so that $p v$ will be twice as great. But absolute temperature is proportional to $p v$, therefore, the absolute temperature will have been doubled when the radius is halved. That is,

$$T = \frac{\text{constant}}{\rho}$$

"This remarkable formula," according to Dr. See, "expresses one of the most fundamental of all the laws of Nature." In simple truth it is an interesting and suggestive formula, and it may throw light upon some of the knotty questions of celestial physics.

Dr. See, in his *Atlantic Monthly* article, says among other things: "It is somewhat remarkable that, while the law of gravitation causes bodies to describe conic sections, the law of temperature for every gaseous body is represented by a rectangular hyperbola referred to its asymptotes, and thus by a particular curve of the same species." Now, it would have been quite as well, or even better, for Dr. See to have said frankly *üm-ta-ra-bum-te-a*, or words to that effect; for, *seriously, the object of popular scientific writing is to develop proper and significant associations, and the bane of popular science is verbal sense which by association becomes absolute nonsense.*

In the *Astronomical Journal* for April 8th Dr. C. M. Woodward calls attention to some of the manifest inaccuracies of Dr. See's derivation of the temperature formula. He points out that the gaseous globe cannot be assumed to have a bounding surface of definite radius ρ ; he calls attention to the fact that the gravitational force at a point does not determine the pressure, but the pressure gradient at the point; and he claims that the hydrostatic pressure at a point varies inversely with ρ^2 , not with ρ , as indicated in the above derivation of the temperature formula. In the above derivation, however,

the pressure is said to increase 16 times, not at the same point in space, but at a point one-half as far from the center.

The objections raised by Dr. Woodward seem to be removed as follows: Consider the gaseous mass at the epoch t . Assume that during the contraction the radius coordinate of every particle decreases in the same proportion (this is what is meant in the above discussion by the invariance of the density function.) Consider the gaseous mass at a subsequent epoch t' when the radius coordinate of every particle has been reduced to one-half its initial value. The density at a distance $\frac{1}{2}r$ from the center at epoch t' is eight times as great as at distance r from the center at epoch t , and the gravitational force is four times as great. Therefore, the weight per unit volume is thirty-two times as great, and this weight per unit volume is the pressure gradient. In integrating the pressure gradients at epoch t and t' , respectively, imagine the paths of integration to be broken up into homologous elements. The elements at epoch t' are then half as long as at epoch t , and, therefore, the integral at epoch t' from infinity to $\frac{1}{2}r$ is sixteen times as great as the integral at epoch t from infinity to r . Therefore, the pressure at homologous points is increased sixteen times when the mass of gas has contracted to half its initial dimensions, as stated in the above derivation.

W. S. FRANKLIN.

NOTES ON INORGANIC CHEMISTRY.

AN attempt is described in the *Chemiker Zeitung*, by Johann Walter, to concentrate solutions by means of a centrifugal apparatus. But while even very light and finely divided precipitates are rapidly separated by centrifugal force, an examination of different portions of a solution, taken while the machine was in rapid motion, showed that the composition was constant. The same was found true in the case of gaseous mixtures, no tendency being found for the denser constituent to collect in the most rapidly rotating portion of the vessel. This affords an interesting experimental confirmation of what might have been theoretically expected from the laws of gases and of solutions.

THE heat of formation of anhydrous oxid of

calcium has lately been redetermined by Henri Moissan from the action of water on crystallized metallic calcium. The value was found to be $\text{Ca} + \text{O} = +145$ cal. This value is greater than that for the oxids of potassium (+98.2) and sodium (+100.9), from which it appears that calcium can replace these metals in their oxids. It is also slightly greater than that of the oxid of lithium (+141.2). Corresponding to this, metallic lithium was obtained by heating the oxid with metallic calcium at a red heat. The heat of formation of magnesium oxid as found by Thomsen is +143.4, but the previous observations of Winkler were confirmed, that at a low red heat calcium is freed from its oxid by magnesium. It is suggested, therefore, that the observation of Thomsen is erroneous, owing to impurities present in the metal used.

It is interesting to find a paper from a Spanish chemist in a recent *Comptes Rendus*. J. R. Mourelo, of Madrid, describes the preparation of phosphorescent strontium sulfid from the carbonate. Finely powdered strontianite and sulfur were heated in boats in a porcelain tube while a current of nitrogen was passing. In no case was a crystalline sulfid obtained. If the strontium carbonate was pure, especially free from alkalis, the sulfid was not phosphorescent. If the temperature was too high (above a bright red heat), or if the nitrogen current was too rapid, the same was the case. The best results were obtained by using a strontianite which contained 96.12% strontium carbonate, 2.03% calcium carbonate and traces of water, manganese and iron. Particularly are the traces of manganese necessary if the strontium sulfid is to be highly phosphorescent.

A STUDY of aluminum has been made by P. Degener as to its use for culinary utensils, and published in the *Hygienische Rundschau*. While aluminum is but slightly acted on by weak acids when they are pure, in the presence of sodium chlorid it is rapidly attacked, as, for example, by sulfur dioxide, acetic acid, and even by alum. The inference is that some considerable danger attends the use of aluminum vessels in the preparation of many kinds of food. Whether, as a matter of fact, the amount which would be dissolved would do injury in the sys-

tem remains a mooted question. While many experiments seem to indicate that aluminum salts have a somewhat detrimental effect upon digestion, yet it is well known that the inhibition of large quantities of alum water is often found very beneficial to health, and many alum springs enjoy a high reputation.

J. L. H.

THE NAPLES ZOOLOGICAL STATION.

WE have recently received from Professor Anton Dohrn, the Director of the Zoological Station at Naples, a complete list of the American biologists who have worked at various times at the Naples Zoological Station. It is probable that the future demands upon the Naples tables will be quite as great as the present and the past, and the three tables, or rather two and one-half tables, which are now supported by subscriptions from this country, should be continued. Professor Dohrn has never raised any technical question of rights, but has always welcomed every American investigator. The least we can do in return is to extend to his institution the strongest support.

The Americans who have worked in the Zoological Station, the Tables they have occupied and the periods during which they were in attendance are as follows:

<i>Zoological Station.</i>			
Professor Whitman, Boston. . .	12 11 81	2 5 82	
Miss O'Neill, H.	11 3 98	22 4 98	
<i>Austria.</i>			
Dr. H. K. Corning.	6 4 92	10 5 92	
<i>Baden.</i>			
Mr. H. B. Ward, Troy.	7 3 90	8 4 90	
<i>Bavaria.</i>			
Dr. B. Sharpe.	19 3 83	26 5 83	
Dr. B. Dean, Columbia.	27 4 92	3 6 92	
<i>British Association.</i>			
Dr. N. Cobb, Spencer, Mass. . .	11 11 88	27 1 89	
<i>Cambridge.</i>			
Miss E. A. Nunn.	22 11 82	1 5 83	
<i>Hamburg</i>			
Dr. W. W. Norman, Ind.	5 10 89	21 3 90	
<i>Williams College.</i>			
Prof. E. B. Wilson, Baltimore. .	30 3 83	20 10 83	
Prof. S. F. Clarke, Williams-			
town	8 1 84	1 5 92	

University of Pennsylvania and Zoological Station

Dr. Ch. Dolley, Rochester....	15	1	85	18	6	85
Dr. W. Patten, Boston (Zool.						
St. Table, 14/4/85 18/6/85..	14	4	85	23	4	85

Davis Table.

Dr. H. I. L. Russell.....	20	3	91	6	7	91
Miss I. B. Platt, Boston	7	4	91	2	7	91
Prof. E. B. Wilson, Phila.....	11	1	92	1	7	92
Dr. I. W. Field, Baltimore ..	5	10	92	29	3	93
Dr. G. H. Parker, Cambridge,						
Mass.	10	3	93	1	6	93
Prof. C. W. Hargitt, Syracuse	10	3	93	1	6	93
Prof. J. Gardiner, Boulder....	1	10	94	1	3	95
Dr. Ida Hyde, Chicago.....	12	3	96	1	5	96

Smithsonian Institution.

Dr. G. Fairchild, Washington.	16	11	93	17	3	93
Dr. W. H. Wheeler, Chicago..	30	12	93	14	4	94
Prof. H. C. Bumpus, Providence	25	1	94	2	4	94
Dr. L. Murbach, Berkey, Ohio.	25	4	94	23	6	96
Prof. T. H. Morgan, Bryn						
Mawr	29	10	94	15	7	95
Prof. Herb. Osborne, Ames ...	15	12	94	7	3	95
Mr. W. T. Swingle, Washing-						
ton	10	3	96	30	5	96
Dr. MacFarland, California..	11	3	96	24	3	96
Prof. F. H. Herrick, Cleveland,						
Ohio	6	11	96	4	12	96
Dr. E. Meek, Washington	19	3	97	5	5	97
Dr. H. Jennings, Michigan....	10	4	97	25	6	97
Dr. H. Neal, Cambridge, Mass.	16	4	97	25	5	97
Mr. B. M. Davis, Chicago....	29	10	97	3	12	97
Prof. H. W. Conn, Brooklyn..	11	3	98	24	4	98
Prof. D. Mottier, Indiana Univ.	12	3	98	18	4	98
Mr. W. T. Swingle, Washington.	22	3	98	28	4	98
Dr. J. R. Gerould, Dartmouth.	3	11	98			

Harvard College.

Mr. E. Rice, Middletown....	23	3	94	12	5	94
Dr. C. Child, Chicago.....	4	6	94	6	12	94
Prof. W. E. Ritter, Berkeley..	14	9	94	29	12	94
Prof. J. Reighard, Michigan..	2	4	95	3	6	95
Prof. C. C. Nutting, Iowa....	1	6	95	17	8	95
Dr. R. T. Harrison, Baltimore.	1	2	96	1	5	96
Dr. R. C. Coe, New Haven....	17	3	96	6	5	96
Dr. A. Weyse, Boston.....	19	3	96	18	6	96

Columbia University, One-Half Year (Resp. University Table).

Dr. A. Matthews, New York..	19	3	96	28	6	96
Dr. J. Graham, New York....	9	4	97	14	6	97
Dr. E. O. Hovey, New York..	3	11	97	4	12	97

Woman's College Table.

Prof. Miss M. Willcox, Welles-						
ley College.....	9	4	98	20	5	98
Miss Peebles Florence.....	2	9	98	19	11	98

The three tables now being supported in this country are as follows :

Smithsonian Table.—Applications should be addressed to Professor S. P. Langley, Smithsonian Institution, Washington, D. C.

University Table.—The main subscription is by Wm. E. Dodge, Esq., of New York, in the name of Columbia University. The American Society of Naturalists has also subscribed \$50 towards this table for the year 1899. Applications should be addressed to Professor T. H. Morgan, Bryn Mawr, Pa.

Women's College Table.—Supported by subscriptions from colleges, associations and private individuals.

Applications should be sent to Miss Ida H. Hyde, 91 Langdon St., Cambridge, Mass.

Students and investigators intending to visit the Station should apply to Dr. Anton Dohrn for a printed circular giving them all the necessary information as to preparation and the procedure to be observed on arrival.

SCIENTIFIC NOTES AND NEWS.

At a recent meeting of the Board of Trustees of the University of Pennsylvania the Provost was authorized to extend an invitation to the American Association for the Advancement of Science to hold its meeting in 1900 at the University.

THE medical department of Johns Hopkins University has sent a party to Manila to study the tropical diseases prevalent there in the hot season. The party includes Dr. Simon Flexner, recently elected professor of pathology in the University of Pennsylvania, and Dr. L. F. Barker, associate professor of anatomy at Johns Hopkins University.

THE field work of the United States Biological Survey during the present season will be mainly in Texas and California. Vernon Bailey, chief field naturalist of the Survey, has begun work on the coast of Texas, and will work westerly to and across the Staked Plains. Later he will join Dr. Merriam in California.

Nature states that Mr. J. Stanley Gardiner, Balfour student of the University of Cambridge, and Mr. L. Borradaile have gone to the Island of Minikoi, situated between the Maldive and

Laccadive Islands, to study the formation of coral reefs, with special reference to the depth at which the reef-building coral organisms live, the food of the coral polyps, the influence of currents upon coral formations and upon the distribution of life near them, and the inter-relationship existing between the various organisms which occur on a coral reef. It is also proposed to survey the Maldive Islands, with a view to obtaining information as to their mode of formation. Mr. C. F. Cooper will join the expedition during the summer.

PROFESSOR T. E. THORPE has been elected to succeed Professor Dewar as President of the Chemical Society, London, while Professor W. A. Tilden succeeds Professor Thorpe as treasurer. Dr. A. Scott has been elected one of the secretaries.

THE Seventh Dutch Scientific and Medical Congress opened its sessions at Harlem on April 7th. Professor Ramsay made an address before the Section of Chemistry on 'The New Elements.'

THE first *conversazione* of the Royal Society will be held at Burlington House on Wednesday, May 3d, at 9 p. m.

It is proposed to erect a memorial statue of Sir Thomas Browne in Norwich, where the author of the *Religio Medici* practised as a physician for forty-six years. It is estimated that the statue will cost about £2,000, towards which the sum of £200 has been subscribed.

A PLAN has been proposed for erecting a monument to Dr. Jean Hameau, of La Test, who is said to have discovered and applied the principles of microbic disease forty years before Pasteur.

THE death is announced of Dr. Franz von Hauer, formerly head of the Austrian Geological Survey, at Vienna, aged seventy-three years; of Dr. Max Durand-Fardel, President of the French Society of Hydrology, and of the Hon. F. F. Thompson, of New York, who gave Williams College scientific laboratories costing \$180,000, and generous gifts to other educational institutions.

WE regret also to record the death of Dr. George Henry Rohé, of Maryland, at New

Albany, La., while in attendance at the recent National Prison Congress. Dr. Rohé was at the time of his death President of the American Public Health Association.

THE death, at the age of 81 years, occurred on April 7th, of Mr. Joseph Stevens, the well-known geologist and antiquarian. Though a practising physician, he found time to make discoveries of neolithic and paleolithic implements and fossils, many of which are deposited in the Reading Museum, of which he was long honorary curator. He was the author of numerous publications on anthropological and archaeological subjects.

MISS E. BROWN, to whose death we recently referred, has bequeathed one of her observatories with all the contents, and, in addition, £1,000, to the British Astronomical Association. Miss Brown was Director of the Solar Section of the Association.

THE Barnard Botanical Club will give an exhibit of the work of the department of botany on the afternoon of April 28th. It is hoped that at that time the bronze tablet, given by the Club in memory of the late Dr. Gregory, will be in place. It bears the following inscription: "This laboratory, for the study of physiological botany, is dedicated to the memory of Emily L. Gregory, Ph.D., first professor of botany in Barnard College, from its opening, in 1889, until her death, in 1897."

MR. W. S. LEAN has bequeathed £50,000 to the British Museum for the extension of the library and reading room.

By the will of the late Sir William Jenner, £10,000 is bequeathed to the Royal College of Physicians of London.

THE Hon. Stevens Salisbury has presented to the Worcester Natural History Society the collection of minerals and fossils made by Mr. John Gilman.

ARRANGEMENTS have been made for the establishment of an anthropological museum at the University of Aberdeen. Several collections have already been presented to the University.

A SUBSCRIPTION has been opened in Scotland for erecting a stone over the tomb of Professor

Macgillivray, the ornithologist, in the New Calton cemetery, Edinburgh, and for founding a Macgillivray gold medal in Aberdeen University as a prize to the best student in zoology, botany or geology.

It is stated in *Nature* that some recognition will shortly be made of the services rendered to geological science by the Rev. Thomas Wiltshire, professor emeritus of geology in King's College, London. Of late years Mr. Wiltshire's labors have not been of a nature to bring his name prominently before the public, but he has been toiling quietly as the honorary Secretary and Editor of the Paleontographical Society. That Society has now published fifty-two quarto annual volumes, and some thirty of these have been edited by Mr. Wiltshire. These volumes each contain forty or fifty plates of fossils, and two hundred or more pages of letter press, dealing with organic remains of all classes. Great credit is due to Mr. Wiltshire, and the members of the Paleontographical Society (of which Dr. Henry Woodward, F.R.S., is President, and Mr. R. Etheridge, F.R.S., Treasurer) have decided to present him with a testimonial, towards which subscriptions (not limited to members of the Society) are now being received.

It is stated that the French authorities are so gratified with the success of the wireless telegraphy demonstrations between Boulogne and the South Foreland that an attempt to telegraph from Paris is proposed, and that the Eiffel Tower will be the French terminal. The English terminal will remain at the South Foreland. The direct distance between the two points is about 230 miles.

We have received the first part of the first volume of the Proceedings of the Washington Academy of Sciences issued on April 14, 1899. It consists of the first annual report of the Secretary, Mr. G. K. Gilbert. This is an interesting account of the foundation of the Academy, including the events antecedent to its formation, most of which have been recorded in this JOURNAL. It is said that the Proceedings will be continued with the publication of scientific papers.

THE Geological Society of Washington has issued the address of the retiring President, Mr. Arnold Hague, on 'Early Tertiary Vol-

canoes of the Absaroka Range,' originally published in this JOURNAL, together with an abstract of the minutes of the Society for the years 1897 and 1898. In 1898 forty-one papers were presented, the average attendance at the meetings being thirty-five. The present officers of the Society are: President, Whitman Cross; Vice-Presidents, J. S. Diller, C. W. Hayes; Treasurer, M. R. Campbell; Secretaries, T. W. Stanton, David White; Members-at-Large of the Council, S. F. Emmons, Geo. P. Merrill, Bailey Willis, N. H. Darton, A. H. Brooks.

LORD KELVIN has just prepared a report on some interesting investigations made by Professor Archibald Barr and himself in Edinburgh, Bradford and Oldham on the subject of the destruction of town refuse. According to the *London Times* the report is not only of great interest to local authorities, but to the general public. In one instance he experimented on damp ashpit refuse containing a large proportion of night soil and vegetable matter from markets and shops. This was consumed without the slightest trace of smoke. In addition to this solution of the smoke difficulty the residual products proved to be of great commercial value. In another case the steam produced by the process of destruction was utilized for the driving of electric lighting machinery and other power purposes. No coal or coke whatever was employed, and in this instance also there was an entire absence of smoke. Lord Kelvin's report demonstrates that public bodies have no longer any excuse for referring to 'waste products,' but have within their reach the means of turning the most unpromising kinds of refuse to a highly profitable account.

THE Twenty-Seventh Annual Meeting of the American Public Health Association will be held at Minneapolis, Minn., beginning October 31st, and continuing until November 4, 1899. The Executive Committee has selected the following topics for consideration: (1) The Pollution of Water Supplies; (2) The Disposal of Garbage and Refuse; (3) Animal Diseases and Animal Food; (4) Car Sanitation; (5) Steamship and Steamboat Sanitation; (6) The Eti-

ology of Yellow Fever; (7) The Relation of Forestry to the Public Health; (8) Demography and Statistics in their Sanitary Relations; (9) The Causes and Prevention of Infectious Diseases; (10) Public Health Legislation; (11) The Cause and Prevention of Infant Mortality; (12) The Period during which Each Contagious Disease is Transmissible and the Length of Time for which each Patient is Dangerous to the Community; (13) Sanitation, with special reference to Drainage, Plumbing and Ventilation of Public and Private Buildings; (14) Method of International Arrangement for Protection against the Transmission of Infectious Diseases; (15) Disinfectants; (16) To Examine into the existing Sanitary Municipal Organizations of the Countries belonging to the Association with a view to Report upon those most successful in Practical Results; (17) Laboratories; (18) To define What Constitutes an Epidemic; (19) National Leper Home; (20) Revision of Classification of Diseases; (21) Dangers to the Public Health from Illuminating Gas Leakage.

A CORRESPONDENT of the London *Times* calls attention to a passage in *The Spectator* (No. 241, 1711) which is interesting in connection with wireless telegraphy and telegraphy in general. The passage read thus: "Strada in one of his Prolusions gives an account of a chimerical correspondence between two friends by the help of a certain loadstone, which had such virtue in it that if it touched two several needles, when one of the needles so touched began to move, the other, though at never so great a distance, moved at the same time and in the same manner. He tells us that the two friends, being each of them possessed of one of these needles, made a kind of dial-plate, inscribing it with the four and-twenty letters in the same manner as the hours of the day are marked upon the ordinary dial-plate. They then fixed one of the needles on each of these plates in such manner that it could move round without impediment so as to touch any of the four-and-twenty letters. Upon their separating from one another into distant countries they agreed to withdraw themselves punctually into their closets at a certain hour of the day and to converse with one another by means of this their invention. Accordingly when they were

some hundred miles asunder each of them shut himself up in his closet at the time appointed, and immediately cast his eye upon his dial-plate. If he had a mind to write anything to his friend he directed his needle to every letter that formed the words which he had occasion for, making a little pause at the end of every word or sentence to avoid confusion. The friend, in the meanwhile, saw his own sympathetic needle moving of itself to every letter which that of his correspondent pointed at. By this means they talked together across a whole continent, and conveyed their thoughts to one another in an instant over cities or mountains, seas or deserts."

UNIVERSITY AND EDUCATIONAL NEWS.

IN its session just closed the Legislature of Nebraska made provision for the University of Nebraska for the biennium ending March 31, 1901, as follows: University salaries, \$230,000; University expenses (including U. S. funds for agricultural and mechanic arts), \$172,500; buildings and other improvements, \$93,500.

THE Queen has appointed the Earl of Kimberley, K.G., to be Chancellor of the University of London, in lieu of the late Lord Herschell.

THE University of Chicago has awarded eighty-one fellowships, of which the following are given in the sciences: *mathematics*, G. A. Bliss, H. Lloyd, W. Findlay, D. N. Lehmer, J. H. MacDonald; *astronomy*, C. E. Rood, W. S. Adams, A. C. Lunn; *physics*, H. O. Murfee, R. F. Earhart, C. W. Chamberlain, F. Reichmann; *chemistry*, H. E. Goldberg, W. McCracken, M. D. Slimmer, S. F. Acree; *geology*, W. W. Atwood, W. N. Logan, R. George, W. T. Lee, W. G. Tight; *zoology*, H. E. Davies, R. S. Lillie, F. M. Guyer, H. H. Newman; *botany*, A. C. Moore, B. E. Livingston, S. M. Coulter, F. M. Lyon; *physiology*, R. B. Rogers, W. E. Garrey, R. W. Webster; *neurology*, D. M. Shoemaker; *sociology*, R. G. Kimble, A. T. Freeman, A. D. Sorenson; *anthropology*, A. W. Dunn; *pedagogy*, W. A. Clark; *philosophy and psychology*, H. W. Stuart, H. B. Thompson, R. L. Kelly, H. H. Bawdin.

SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; J. LE CONTE, Geology; W. M. DAVIS, Physiography; HENRY F. OSBORN, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; J. McKEEN CATTELL, Psychology; DANIEL G. BRINTON, J. W. POWELL, Anthropology.

FRIDAY, APRIL 28, 1899.

CONTENTS:

<i>The Revival of Inorganic Chemistry:</i> DR. H. N. STOKES,	601
<i>On the Total Solar Eclipse of May 28, 1900:</i> PROFESSOR TRUMAN HENRY SAFFORD.....	615
<i>Reception and Exhibition of the New York Academy of Sciences:</i> PROFESSOR WILLIAM HALLOCK..	616
<i>Scientific Books:—</i>	
<i>Campbell on the Evolution of Plants:</i> PROFESSOR CHARLES E. BESSEY. <i>Groos's Die Spiele der Menschen:</i> HIRSH M. STANLEY. <i>Books received</i>	618
<i>Scientific Journals and Articles</i>	620
<i>Societies and Academies:—</i>	
<i>The National Academy of Sciences. The Philosophical Society of Washington:</i> E. D. PRESTON. <i>Geological Society of Washington:</i> DR. W. F. MORSELL. <i>Chemical Society of Washington:</i> DR. W. H. KRUIG. <i>Minnesota Academy of Natural Sciences:</i> CHARLES P. BEEKEY. <i>The Academy of Sciences of St. Louis:</i> PROFESSOR WILLIAM TRELEASE. <i>Boston Society of Natural History:</i> SAMUEL HENSHAW	621
<i>Discussion and Correspondence:—</i>	
<i>The Action of the Coherer:</i> M. F. LOCKWOOD, E. B. WHEELER. <i>Two-Headed Snakes:</i> ROWELL H. JOHNSON. <i>Duplication of Geologic Formation Names:</i> F. B. WEEKS	624
<i>Notes on Inorganic Chemistry:</i> J. L. H.....	626
<i>Current Notes on Meteorology:</i>	
<i>Frost Prediction and Protection; A Fog Dispellor;</i> Notes: R. DeC. WARD.....	627
<i>Scientific Notes and News:—</i>	
<i>The American Association for the Advancement of Science; Geological Survey Work in Alaska:</i> W. F. M. <i>Scientific Positions under the Government; General</i>	628
<i>University and Educational News:—</i>	
<i>Assistants in Physiology in Harvard Medical School; General</i>	631

MSB. intended or publication and books, etc., intended for review should be sent to the responsible editor. Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

THE REVIVAL OF INORGANIC CHEMISTRY.*

NOTHING can be more instructive to the student interested in the results of intellectual cross-fertilization than the effect of the recent fecundation of chemistry by physics. Through the application of physical methods and ideas to chemistry, the latter has given birth to a new branch of study, physical chemistry, which promises to produce as radical a change in our conceptions of molecular phenomena as did the overthrow of the phlogiston theory or the introduction of the conception of valency at a later period.

The attempt of Berthollet to introduce dynamical conceptions into chemistry, at the beginning of the century, fell on thorny ground, and from that day until very recent years the growth of chemistry, great as it has been, has been most remarkably one-sided. The Periodic Law has been discovered, many new elements have been found, new compounds without number have been prepared, the rules governing their formations and transformations have been ascertained, and even their microscopic anatomy has been studied to such an extent that for countless of them we have established formulas which express, schematically, the relative arrangement of the atoms in the molecule. In stereochemistry we have even gone so far as to be able to

*Annual address of the President of the Chemical Society of Washington, delivered March 30, 1899.

indicate, in a rough way, the actual relations of the atoms in space; yet, with all this, a most important part of the problem has been almost neglected. To use a biological expression, chemistry has been enormously developed on the morphological, and but little on the physiological side. Chemists have concerned themselves greatly with the products of chemical reactions, and but little with the nature of the reactions themselves. The molecule has been treated as a dead, rigid body is treated by the anatomist, but its study as a living, moving mass, filled with energy and capable of reacting by virtue of this energy, has been largely left to the future. Even as late as 1882 the German physiologist Emil du Bois-Reymond used the words which have since been in the mouth of every physical chemist:

"In contradistinction to modern chemistry, we may call physical chemistry the *chemistry of the future*."

Since 1882, thanks to the labors and inspiring influence of Ostwald, van't Hoff, Arrhenius, Nernst and others, physical chemistry is no longer the chemistry of the future merely, but of the present, and apart from the quickening influence which it is exerting in nearly all branches of chemistry proper, both pure and applied, we are beginning to perceive that we are entering a period in which chemistry will be of greater service to the allied sciences. Geological chemistry is showing signs of reviving under the stimulus of physico-chemical conceptions, and we are finding, too, that as physiological chemistry is not merely the chemistry of sugar, or urea, or albumin, but preeminently a science of moving and changing molecules, it can only progress by the aid of a knowledge of the laws of chemical energy.

The achievements of physical chemistry form, perhaps, the most interesting phase of the recent history of our science, but its

followers have spoken for themselves so often of late years, and have presented the subject so much better than I could do it, that I feel compelled to consider a perhaps humbler, but yet not unimportant, field of research, which, in a sense, may also be called a part of the chemistry of the future, the field of *Inorganic Chemistry*. The relations of physical and inorganic chemistry have recently been discussed by van't Hoff in his admirable address delivered last summer before the Society of German Scientists and Physicians, and I shall, therefore, limit myself to the consideration of a few points of a more strictly chemical nature, touching the relations of physical and inorganic chemistry only incidentally.

The aim of physical chemistry will have been accomplished when it has established a mathematical equation which, by proper substitution, will enable us to predict the nature of every possible chemical system or reaction, and the properties, physical and chemical, of every possible element or compound. Until he has reached this chemical millennium, unless he will risk falling into the pit which has received so many philosophers in the past, the chemist must continue to advance by the route by which our understanding of every other branch of physical science has been reached. Notwithstanding all that physical chemistry can do with this material at present in hand, the experimenter must long continue to take the short cut to knowledge and find out what his elements and compounds will do by first actually getting them in hand, by precipitation, filtration, distillation, crystallization and the like. It may be questioned whether our present knowledge of facts would ever suffice to enable us to predict, for example, a single atomic weight with accuracy, or to explain that wonderful relation between properties and atomic weights known as the Periodic Law. A few enthusiastic physical chemists have

spoken slightly of the compound-maker, as a kind of inferior being, apparently forgetting that it is just this kind of pioneer work which has supplied the material for their labors, that the first requisite for successful generalization is the possession of a large number of pure substances, of accurately known composition and properties, many of which can only be obtained by work which is so elaborate and difficult, and which requires such concentration of effort that he who follows it can well be excused if he does not always look on the product of his labor as merely means to another end. It is tolerably clear that, for a long time to come, experimentizing must keep equal pace with mathematicizing, and if the former have been pushed so far in one direction as to appear to afford no prospect of continued progress we must not abandon it altogether, but consider whether it may not be still profitably pursued along other lines. Let us consider whether we must all turn mathematical chemists, or whether there is not much left to be done by those trained in the older school, working along old-fashioned lines and by old-fashioned methods.

Descriptive chemistry, as it exists to-day, is a science which has grown and is still growing enormously in a single direction, that of organic chemistry, the chemistry of the compounds of carbon. We are at present acquainted with about seventy-five chemical elements, which are found in the most varied proportion in those parts of the earth which are accessible to our observation, namely, the crust, the sea and the air. The accompanying table, calculated by Clarke, shows the relative abundance of the elements in a sphere comprising the crust for a depth of ten miles, the ocean and the atmosphere :

Oxygen	49.98
Silicon.....	25.30
Aluminium.....	7.26
Iron	5.08

Calcium	3.51
Magnesium.....	2.50
Sodium	2.28
Potassium	2.23
Hydrogen .....	.94
Titanium.....	.30
Carbon .....	.21
Chlorine } .....	.51
Bromine }	
Phosphorus.....	.09
Manganese .....	.07
Sulphur.....	.04
Barium .....	.03
Nitrogen .....	.02
Chromium.....	.01

The nineteen elements here given make up nearly the whole mass ; the remaining fifty-five or thereabouts, taken together, and making all possible allowance for error, do not amount to more than at most 1 per cent. Observe that the element *carbon* amounts to but one-fifth of 1 per cent. To be sure, this is no argument that the chemistry of carbon is relatively unimportant ; on the contrary, there is no necessary connection between the abundance of an element and its ability to carry us further toward a knowledge of chemical laws. Nevertheless, to an intelligence not having its seat in a body largely made up of carbon compounds, it might appear somewhat surprising that chemists should have attempted to base a science on the investigation of an element which exists in such relatively insignificant amounts, the compounds of which, with but few exceptions, are incapable of formation at the freezing point of water, or of existence at the lowest red heat ; and should have chosen to devote nearly all of their energy to its study.

Apart from the special subject of coal, petroleum and asphalt, carbon is of practical importance to the geologist only in the form of carbon dioxide and the carbonates, while of the chemical properties of silicon, which constitutes 27 per cent. of the earth's crust, and of the silicates, which make up nearly all of it, we know vastly less than of the

derivatives of the single carbon compound, *benzene*. A study of the chemical changes taking place in the sun, and of most of those occurring in the interior of the earth, might almost leave carbon out of account; it would certainly have no more importance than titanium, an element of which few but chemists have ever heard, but which is more abundant and as widely distributed.

Carbon, as an essential constituent of living beings, constantly forces itself on our attention, yet this is not to be considered as by any means the chief cause of the predominance of organic chemistry. Comparatively few of the best studied organic compounds have more than the remotest connection with the phenomena of life. Phosphorus and sulphur, to say nothing of oxygen, hydrogen and nitrogen, are quite as important in this respect as carbon, yet how relatively little do we know of phosphorus and sulphur in their chemical relations, or even of nitrogen. The extraordinary development of carbon chemistry is due mainly to reasons of a chemical nature, which, by rendering its compounds easier to study, have made progress in this direction a line of least resistance. This has not been without its advantages, for we have been led to discern laws which could not have been perceived so soon had the working forces been more evenly distributed, but it has also had the unfortunate result that the theories of molecular structure, derived wholly from the study of carbon compounds, have been applied to all classes of inorganic compounds too hastily and without sufficient research. The inorganic chemist has done little but make new compounds, and ascribe to them structural formulas seldom based on the results of experiment, but rather on the possibility of drawing schemes on paper, in which the various valences or bonds were mutually satisfied (how, did not matter much), while those substances which were inconsiderate

enough to refuse to submit to this operation without violating every probable or possible assumption have been labeled 'molecular compounds,' and under this name submitted to a forced neglect, which soon resulted in their being forgotten. We shall presently see that an increasing respect for these so-called molecular compounds is one of the features of the revival of inorganic chemistry.

In the earlier days of chemistry no sharp line was drawn between inorganic and organic substances. It is generally thought that we owe this distinction to Nicholas Lémery, who, in 1675, classified substances, according to their origin, as mineral, vegetable and animal, a distinction which has survived until the present day in popular speech. Lavoisier, recognizing in substances of vegetable and animal origin the elements carbon, hydrogen, nitrogen and oxygen, and led by his researches to attribute a peculiar importance to oxygen, regarded inorganic bases and acids as oxides of simple radicals, and organic bodies as oxides of compound radicals composed of carbon, hydrogen and sometimes nitrogen, but did not otherwise distinguish them. Even in 1811 it was undetermined whether carbon compounds obey the laws of constant and multiple proportions, and it was two or three years more before Berzelius, having sufficiently improved the methods of organic analysis, definitely proved that they do, in fact, conform to these laws, but are of greater complexity than the comparatively simple inorganic compounds then known. In his electro-chemical theory, the theory of dualism, developed between 1812 and 1818, Berzelius regarded the simple inorganic bodies, such as the bases and acids, as binary compounds of positive with negative atoms, held together by electrical attraction; the more complex bodies, as the salts, being binary compounds of a higher order; the organic compounds, on the contrary, being

regarded as ternary or quaternary. Later he extended the dualistic conception to these also, adopting the idea of Lavoisier that they are binary compounds of oxygen with compound radicals, composed of carbon, hydrogen and sometimes nitrogen, a view which he developed further and never wholly abandoned. In 1817 we find Leopold Gmelin maintaining that organic compounds are the products of a vital force and cannot be produced artificially. This view was entertained by Berzelius even as late as 1827 or later. Berzelius attributed the formation of organic compounds, with their relatively weak positive and negative characters, to peculiar electrical conditions existing in the organism. We cannot reproduce these conditions in the laboratory, and, therefore, cannot produce organic compounds artificially. Those transformations which we are able to effect are always from the more complex to the simpler. We can isolate the intermediate stages in the breaking-down of organic matter into carbon dioxide, water and ammonia, that is, we can follow the change of matter from the organic to the inorganic, step by step, but we cannot reverse the process and build up, nor can we hope to do so in the future. This opinion of Berzelius marks the widest gulf between organic and inorganic chemistry, a gulf too wide for human power to bridge. How dangerous it is to set limits to the power of science! But one year later, in 1828, Wöhler announced his discovery that urea, a body of animal origin, could be produced from ammonium cyanate, a substance, which, in its turn, can be built up from its constituent elements, carbon, hydrogen, oxygen and nitrogen. This was the first of a series of innumerable syntheses which have fully disposed of the idea that any fundamental distinction exists between inorganic and organic compounds. Although we have not yet made albumin in the laboratory, we all expect that it will be done,

and nearly every chemist now believes that even the properties of living protoplasm are due, not to any peculiar vital force inherent in the protoplasm itself, but to the special properties of the carbon, hydrogen, oxygen, nitrogen, phosphorus and other elements of which it is composed. My subject does not permit me to consider in detail how the idea of organic chemistry, as the chemistry of compound radicals, was evolved; how the radical theory was replaced by the conception of the molecule as a unit; how, in 1853, the theory of valency began to develop, and how this, with the type theory, the theory of the linkage of atoms, and the constant tetravalency of carbon, led, in the early sixties, to our present conceptions of the structure of organic molecules. With the advent of the fully developed structural formula, the brilliant progress of organic chemistry toward fuller theoretical development came to an end with remarkable suddenness. Kekulé's ingenious and fruitful theory of the benzene ring, suggested in 1865, was an application, to a particular class of compounds, of principles already established, but involved no fundamentally new conceptions. Organic chemistry entered upon what has aptly been termed a period of 'formula worship.' The establishment of the constitutional formula became the highest aim of the devotees of this cult, against which but few chemists, for example, Kolbe and Mendelejeff, have had the courage to protest. In pursuing this aim the organic chemists have unquestionably accumulated an enormous mass of valuable information and detail; have discovered new methods of synthesis, new laws of more or less special application and new compounds of practical value; but, with all their labors, the ordinary structural formula of to-day means no more than it did in 1865. In stereo-chemistry, however, the development of the structural formula in space of three dimensions, organic chem-

istry, has shown real progress, especially since 1887, when LeBel and van't Hoff's theory of the asymmetric carbon atom, which was proposed in 1874, but which slumbered almost forgotten, was revived by Wislicenus. At present the most important developments of structural chemistry, both organic and inorganic, unquestionably have the question of space relation as their basis.

The development of inorganic chemistry presents some marked distinctions from that of organic chemistry. Up to the year 1820 nearly all the important discoveries and generalizations came from the inorganic side. Richter's discovery of the law of equivalents; the researches of Scheele, Cavendish, Priestley; the development of the theory of oxidation by Lavoisier; the atomic hypothesis of Dalton and his laws of constant and multiple proportions, and the placing of them on a firm foundation by the remarkable labors of Berzelius; Gay Lussac's law of the simple relation of the volumes of reacting gases; Dulong and Petit's law, and the law of isomorphism, all fall within this period and antedate the beginning of the rapid development of carbon chemistry. The same is true of the discovery of the alkali metals, the recognition of the elementary nature of chlorine, and of the establishment of the existence of hydrogen acids, and many other important facts. In these the study of carbon played a relatively insignificant part. The electro-chemical theory of Berzelius, too, which was of such great importance as a working hypothesis, was of inorganic origin. By 1830 the predominance of organic chemistry was already pronounced, and with the increased attention given to this new field the interest in inorganic chemistry lagged behind. All, or nearly all, the developments of theoretical importance began to come from the inorganic side. The history of chemistry from 1830 to 1865

is practically the history of organic chemistry. I do not mean that research was confined merely to carbon compounds. The influence of Berzelius continued to be felt, and men like Heinrich Rose, Wöhler, Bunsen and many others made valuable contributions to inorganic chemistry, as well as several like Dumas, Liebig and others, whose reputation rests chiefly on their organic work. The great inorganic chemists were mostly men of an analytical rather than synthetical turn of mind. The growth of mineralogy led to the discovery of new elements, and the analytical requirements to which it, as well as practical chemistry, gave rise conduced largely to the study of inorganic compounds. The conception of valency, while due mainly to organic chemistry, owes not a little to inorganic chemistry, though it did but little to further it. Numerous atomic weight determinations of greater or less accuracy were made, sometimes with a purely analytic purpose, sometimes with the object of testing the validity of Prout's hypothesis, but these exercised but little influence on the theoretical growth of inorganic chemistry, which remained for the most part a mass of unconnected facts.

In considering the causes to which is due the preeminent attention given to organic chemistry since 1830, the point most to be emphasized is that at no time since that date has there been lacking a well-defined working hypothesis of the nature of organic compounds. Not only did these substances prove eminently susceptible of classification into types, but, for reasons to be stated later, the transformations discovered were so numerous, and the possibilities of producing synthetically old or new compounds, and of working out new theories, were so attractive that most of the best chemical minds between 1830 and 1865, or even later, were drawn into organic chemistry. Another important factor is that of inertia. Most students of nature do not willingly

enter upon entirely new fields of research. The pupils of the great masters of organic chemistry, Liebig, Dumas, Hofmann, Wurtz, Kolbe, Kekulé and others, found enough to do in following in the footsteps of their teachers, and were little inclined to seek new pastures. The requirements of candidates for the doctorate, whereby the experimental material for the dissertation had to be accumulated in a comparatively short time, led to the assignment of topics with which the instructor was familiar, and which were fairly sure of giving positive results within a year or two, and, as we all know, no branch of chemistry yields results so readily as the study of carbon compounds, with its highly developed synthetical methods. As the *Chemiker-Zeitung* has recently pointed out, even at the present day the full professorships in German universities are almost invariably held by organic chemists, while inorganic chemistry is left to subordinates. The weight of authority and influence being on the side of organic chemistry, the student who looks forward to a university career sees that his chances of promotion are better if he follow the organic rather than the inorganic direction. I need hardly add that the more mercenary hope of obtaining a new dye-stuff or a new remedy, or of replacing nature in making an alkaloid, has also been a powerful incentive to many.

Let us now consider some of the reasons which have their root in the chemical peculiarities of carbon, and which render its compounds, at least those which are not too complex, comparatively easy to study. These conditions are not peculiar to carbon, but no other element, as far as is known, presents as many of them at the same time.

1. Carbon compounds being very generally soluble in neutral solvents, frequently crystalline, and often volatile without decomposition at comparatively low temperatures, are peculiarly adapted to separation

in a state of purity by fractional crystallization or distillation, and for the same reason it is usually possible to determine their true molecular weights. The very general possession of melting or boiling points lying within easily observable ranges of temperature greatly facilitates identification.

2. The power of carbon of uniting, atom to atom, to form chains, the form and size of which can be easily regulated by known synthetic methods, and the stability of which is sufficient to allow of manipulation under easily attainable conditions, is a marked peculiarity of this element. This, with the power of forming stable compounds with hydrogen, is the basis of the definition of organic chemistry as 'the chemistry of the hydrocarbons and their derivatives.' With regard to self-linking power the other elements are in marked contrast. We know with certainty no compounds in which two atoms of boron are linked, not more than four nitrogen atoms have been arranged tandem, while of silicon, the nearest relative of carbon, we know at best a half-dozen well-defined compounds with two atoms of this element in series, and but one with three; analogues of the hydrocarbons are unknown, with the exception of silico-methane, and the instability of this is sufficient proof that a series of silicon paraffines would be most difficult to prepare, and the same would apply to all classes of silicon compounds in which self-linking is a prerequisite. It does not appear probable that we shall ever have a very extensive chemistry of the 'hydrosilicons and their derivatives.' Among the compounds of other elements self-linkage occurs in but few cases and is limited in extent.

3. It is a highly important property of carbon compounds that their molecules tend to preserve their individuality; they generally do not, though there are exceptions, spontaneously avail themselves of opportuni-

ties for condensation, whether by polymerization or by union of two or more molecules with separation of water or ammonia. The so-called double and triple union between carbon atoms only exceptionally leads to spontaneous polymerization, while with silicon this latter is apparently the rule. The important carbonyl group, $C=O$, the characteristic group of organic acids, aldehydes and ketones, shows but little tendency to polymerize, while organic hydroxyl compounds are usually stable and do not spontaneously give rise to ethers or acid anhydrides. The silicon analogue of carbonyl, $Si=O$, on the contrary, appears to polymerize with great ease. The ethers of carbonic acid are well known, but the metasilicic ethers, those of the type $SiO(OR)_2$, appear to exist only as polymers. The silicic acids, too, show a marked tendency to condense by dehydration and pass spontaneously into complex bodies. It is easy to see what would have been the result if carbon behaved like silicon. Instead of the innumerable sharply defined organic acids, aldehydes, ketones and alcohols, each produced by a definite synthetic process, each reaction would give rise to an almost inextricable mixture of condensation products, carbon dioxide would be a solid like silica, and organic chemistry would be scarcely further advanced than is the chemistry of silicon. This tendency of carbon compounds to simplicity in reaction, each molecule acting as if it were alone present, has been, therefore, an important factor in facilitating the growth of organic chemistry.

4. Another feature of carbon, which plays an important part, is the ease with which intermediate or transition products can be formed. It is much easier to limit reactions in the case of carbon compounds than in others. Compare, for example, the action of chlorine on CH_4 and SiH_4 .

5. The tendency to dissociation, both hydrolytic and electrolytic, is in general less

marked among carbon compounds, whence it is easier to control the course of a reaction and to exclude changes of a spontaneous nature. Finally, the carbon compounds show but little tendency to the formation of so-called molecular addition products, of which the metal ammonias, the double salts and the compounds with water of crystallization are examples, the rational interpretation of which is difficult.

A full consideration of the peculiarities of carbon which have facilitated the synthesis of such vast numbers of organic compounds would be beyond the scope of this address. The above are the most important, and their relative absence in the majority of elements explains largely the backward state of our knowledge of them. Our inability to determine the true molecular weight of insoluble and non-volatile substances; the difficulty of limiting reactions so as to obtain intermediate products; of preventing condensations; of separating mixtures and identifying their constituents by such simple methods as melting- and boiling-point determinations; of building up step by step; of dissecting atom by atom; of explaining molecular compounds—these are hindrances which can only be overcome by greater perfection of our experimental methods, and which often render the study of the constitution of inorganic bodies a problem of great difficulty, even in the case of many of the simplest.

At the very time that the organic structural formula was beginning to turn the attention of organic chemists away from a further development of theory to a greater elaboration of details the Englishman Newlands was publishing papers which contained the germ of the Periodic Law. In 1865 Kekulé announced his theory of the benzene ring; in 1864 Newlands showed that if the elements be arranged in the order of their atomic weights 'the eighth element, starting from a given one, is a kind

of repetition of the first, like the eighth note of an octave in music.' This discovery of Newlands of a fact which later developed into the Periodic Law does not, however, mark the beginning of a new direction in chemical thought. It marks rather that point in a long series of speculations at which chemists were beginning to grasp an idea after which they had been groping blindly for many years, the conception that the elements are not wholly unrelated bodies, but that there is some definite law connecting their properties with their atomic weights. Beginning in 1815, with the claim of Prout that the atomic weights of the elements are multiples of that of hydrogen, which led him to suggest that hydrogen is the primitive element from which the others are built up, we find numerous speculations, some devoted merely to finding arithmetical relations among the atomic weights, such as the law of triads, others attempting to show how the elements could be built up from one or more primitive constituents. Most of these did not lead to any marked advance of chemical theory, but Prout's hypothesis found very able defenders and greatly encouraged accurate atomic-weight determinations. The labors of Dumas, Marignac and especially of Stas, in this field, are directly due to the desire to test the validity of Prout's suggestion. Up to 1860 not only were the atomic weights uncertain to within a few decimals, but, for other reasons, even the relative position of the elements in an ascending series was often uncertain; our present empirical formulas had not been fully established; it was uncertain, for instance, whether water was HO with $\text{O} = 8$ or H_2O with $\text{O} = 16$, or whether silica was SiO , with $\text{Si} = 28$ or SiO_2 , with $\text{Si} = 21$. So when Gladstone, in 1853, arranged the elements in the order of ascending atomic weights he failed to perceive any noteworthy relation. Nine years later the

French engineer and geologist de Chancourtois, using the newer and now adopted atomic weights, arranged the elements in a spiral or helical form around a cylinder, in ascending order, and was led to the conclusion that the 'properties of bodies are properties of the numbers,' a vague statement of the now familiar phase that the properties of the elements are functions of their atomic weights. As already mentioned, he was followed closely by Newlands, whose work, however, met with but slight recognition. Time is wanting to show how in the period 1864-1869 the Periodic Law was developed by the labors of Newlands, and more especially of Lothar Meyer and Mendelejeff, working independently. It affords an interesting example of how a great idea is developed about the same time in the minds of several men working independently and unknown to each other. In 1871 Mendelejeff published a table which shows the periodic law essentially as we find it to-day, the only changes consisting in the addition of a few newly discovered elements and in placing a few of the older elements in their proper positions, as a result of more accurate atomic-weight determinations.

The period 1863-1870 was, therefore, of the greatest importance for inorganic chemistry, as it saw the development of the idea that the properties of the elements are *periodic* functions of their atomic weights. The time which has since elapsed has been even more fruitful than any previous period in speculations, having for their object the finding of mathematical relations between the atomic weights and in theories of the evolution of matter from one or two primal constituents. Many modifications of the periodic scheme have been devised, but they present but few or no advantages over the simple arrangement of Mendelejeff and Lothar Meyer. The great fact still remains, unmodified and unimproved, that if the ele-

ments be arranged in the order of increasing atomic weights there is a recurrence of the properties of elements lower in the scale—in short, that these properties are periodic functions of the atomic weights.

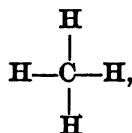
The discovery of the new group of inert gases, helium, neon, argon and xenon, with perhaps krypton and metargon, has not modified our idea of the Periodic Law essentially. They appear to fit well into the system, and it is now only remarkable that their existence was not surmised by Mendelejeff, who so successfully predicted several then-unknown elements. Although the periodic system is, even to-day, the object of attack by a few chemists, who appear to be blinded by its unquestioned defects to the obvious truths which it expresses, it may be safely said that the great central fact of the periodicity in the properties of the elements is just as firmly established as the law of gravitation, and that, whatever modifications may have to be made in the scheme as a whole, this central fact will never be done away with. The atomic theory may be supplanted by something better, but its successor will equally have to take account of the stoichiometrical relations of the elements, which are based not on theory, but on observation pure and simple, and it is on these, and not on the atomic theory, that the Periodic Law is based.

The Periodic Law is exerting a stimulating influence on inorganic chemistry in various ways. It is leading to a more careful study of all the elements, with the object of discovering further analogies; new compounds are being prepared and old ones studied better with this in view; new kinds of periodicity are being sought for in physical as well as in chemical properties. The question of the nature of the rare earth metals, the asteroids of the elementary system, as Crookes calls them, is being attacked with greater energy. Are these, of which Crookes claims there are thirty or

perhaps sixty, capable of being fitted into the system, as it now exists? Must we modify it in order to take them in, or do they represent certain exceptional phases of the evolution of matter from the original protyl, or different very stable modifications or allotropic forms of a few elements? Do the blanks within the system represent existing but as yet undiscovered elements? Do some of them correspond to hypothetical elements which for some unknown reason are incapable of existence, like many organic compounds which are theoretically possible, but which, if momentarily existing, lapse at once into other forms, or must the scheme be so modified as to exclude them? These are some of the questions raised by the Periodic Law which it belongs to the inorganic chemist to solve. Most important of all is the question of the *cause* of the periodicity. Before we can hope to establish a mathematical and possibly a genetic relation between a series of numbers, such as the atomic weights and the chemical properties of the elements, we must establish with greater accuracy than heretofore the precise magnitude of these numbers, and it is this that an ever increasing number of atomic-weight chemists is striving to do. The question of the unity of matter is one to a solution of which we are no nearer than ever, and the Periodic Law, in its present form, does not afford a proof or, I think, even a presumption in favor of a genetic relation between the elements. It is quite conceivable that we may have relations of properties without a common origin. With ever increasing accuracy, we seem to be removing further and further from the possibility of any hypothesis like that of Prout. The electric furnace, with its temperature of 3,500° C., gives not a sign of the decomposition or transformation of the elements. These questions and the query why we know no elements below hydrogen or above uranium, why the num-

ber of the elements is limited, and why there are not as many kinds of matter as there are different wave-lengths of light—all these seem to belong as yet to a scientific dreamland rather than to the realm of legitimate research, yet their solution, if possible at all, will be accomplished only by the labors of the inorganic chemist.

Let us now turn to the more special consideration of the questions of the constitutional formulas of inorganic compounds. The more conservative organic chemists have always been careful to state that the so-called structural formulas are *reaction formulas* merely, that is, that they are not intended to express the actual relations of the atoms in the molecule, but are merely convenient schemes for rendering possible reactions visible to the eye. Probably most chemists regard them as more than this, as actual diagrammatic representations of the way in which the atoms are combined. The formula of marsh gas, for example,

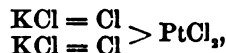


is regarded as more than a visualizing of its chemical properties; it implies that the carbon atom is an actual physical link between the hydrogen atoms, which are combined directly with the carbon but not with each other. Stereochemical formulas are confessedly more than reaction formulas, and the steric conception of the so-called double and triple union asserts that these actually exist in the sense the words imply, and are not merely names for unknown conditions.

Many of the simpler organic structural formulas unquestionably have an enormous mass of evidence in their favor, but many others we must be on our guard against taking too seriously, and must for the present regard as nothing more than reaction

formulas. That we can regard any of them as well established is due, more than to anything else, to the almost invariably constant tetravalency of the carbon atom. Unfortunately, the valency of many of the elements entering into the composition of inorganic compounds appears to be extremely variable and uncertain, and this has greatly impeded the study of the structure of these bodies. The inorganic chemist has been far too prone to assume that the structural theories of the organic chemist are of universal applicability, and, having once for all attributed a certain valency to an element, has been often content with devising structural formulas which have no better claim to recognition than that all the so-assumed bonds are 'satisfied.' At other times a particular valency has been assumed for no other reason than that it enabled him to contrive a formula for the special case under consideration. The books treating of such matters frequently exhibit wonderfully ingenious inorganic structural formulas which are wholly devoid of a reasonable amount of experimental evidence and which are, therefore, often nothing but pure rubbish. With many inorganic chemists, formula worship has degenerated into fetishism. Let us consider a few examples. For nitric acid, one of the simplest and most familiar inorganic compounds, several constitutional formulas may be written, in which the hydrogen is directly united to the nitrogen or separated from it by one or two oxygen atoms, and in which nitrogen may be either tri- or pentavalent. Some of these are given in the books as if they were gospel truth. Brühl, who has investigated the question by physical methods, suggests that the hydrogen atom is not directly united to any part of the NO₂ radical, but is rotating around it and possibly combined with each oxygen atom in succession, a view approaching that of Werner. There are at least five formulas

proposed for this simple acid. For the familiar potassium chloroplatinate, K_2PtCl_6 , there are four constitutional formulas seriously advocated at present. It may be K_2PtCl_6 , with octavalent platinum;



with tetravalent platinum and trivalent chlorine, as required by Remsen's theory; $(PtCl_3)K_3$, in the sense of Werner's theory, the two potassium atoms being combined with the $PtCl_3$ as a whole, or it may be a molecular compound in which two molecules KCl as wholes combine with $PtCl_4$ as a whole. The formulas suggested for most minerals are pure guess work. The silicates are usually written as if containing the group $Si=O$, by analogy with carbonyl, $C=O$, yet there is not a single silicate in which this assumption rests on any experimental evidence, and the little we do actually know of the chemical behavior of silicon speaks against it. Such formulas, if not purely speculative and devoid of all basis and all value, as they frequently are, at best do not represent structure in the sense that the best established organic formulas do; they are at most reaction formulas only, or they represent partial molecules, in the same way that CH may stand for benzene (C_6H_6) or HPO_3 for a metaphosphoric acid. The attempt to interpret the double salts and halides, the compounds with water of crystallization or hydration, the metal-ammonias, the peculiar compounds of the zeolites described by Friedel, and other so-called molecular compounds, in the sense of the valence hypothesis, seems almost hopeless without taking such liberties with it as to render it nearly useless, and without making assumptions of very narrow and limited applicability. One may well question whether this hypothesis must not be very considerably qualified before it can be taken as the basis

of a general theory of the structure of inorganic compounds.

One of the most striking indications of a revival of inorganic chemistry is the recent attempt of Werner to break away from the bonds of the organic-structure theory as applied to inorganic compounds and to establish a more general theory in which valency plays a comparatively insignificant rôle. The arguments on which Werner's hypothesis is founded are too numerous and elaborate to be presented here. Suffice it to say that it was primarily based on that peculiar class of bodies known as the metal-ammonias, consisting of metallic salts, combined with usually six or four molecules of ammonia, and in which the ammonia may be wholly or in part replaced by pyridine, water, acid radicals and other groups. These groups are supposed to be arranged symmetrically about the metallic atom, forming a radical, which, according to its nature, can combine *as a whole* with metals, halogens or other positive or negative groups. Thus, in the compound $Co(NH_3)_4Cl_2$, cobalt forms with NH_3 a radical, which combines as a whole with the three chlorine atoms; in $(PtCl_3)K_3$ the two potassium atoms are combined with the whole group $PtCl_3$ and not attached to any one part of it; the same applies to $(NH_3)_4Cl$, and to $K_2(SO_4)$ and $K_4(FeCN)_6$. In the formation of these radicals the bivalent NH_3 , the neutral H_2O and the univalent Cl can replace each other indiscriminately; the valence theory is, therefore, practically thrown overboard entirely and in place of combination by bonds we have an extension of the old theory of molecular compounds applicable alike to the metal-ammonias, the ordinary oxygen salts, the double halides and the compounds with water of crystallization. It is yet too soon to predict the future of this hypothesis, which has already won numerous active adherents. It is scarcely too much to hope

that it will lead, perhaps with some modifications and extensions, to a more comprehensive theory of structure, and to a clearer definition of the as yet only vague conception of valency. It is the broadest generalization of inorganic chemistry since the discovery of the Periodic Law, and shows that inorganic chemists are no longer willing to be mere imitators and to close their eyes to the existence of whole groups of bodies which do not tally with current theories, and are beginning to see that in these is to be sought the key to a broader inorganic chemistry.

The slow development of inorganic chemistry during the period from 1830 to 1865, as compared with that of organic chemistry, was due, as has been seen, in part to the greater breadth and greater diversity of the field, to the relative absence of leading ideas and leading motives, and to the comparative tractability of carbon compounds as compared with inorganic compounds under the restrictions of the experimental methods in vogue. Prout's hypothesis and allied speculations gave a working hypothesis for a limited number of investigators, but the uncertainty of the atomic weights, which in part was conditioned by the imperfection of analytical methods, prevented any satisfactory results being reached. Absolute purity of materials and absolute accuracy of analytical methods are not of the first importance to the organic chemist, to whom errors of one or two points in the first decimal are seldom of any significance. To the atomic-weight chemist, on the contrary, accuracy is the very first point to be considered; not only must his material be absolutely free from impurities, but his methods must be beyond criticism, and it is only with the increasing perfection of analytical methods, admitting not only of quantitative determinations of the greatest accuracy, but also of the detection of traces of impurities which for ordinary purposes are negligible,

that this kind of work has offered inducements to a large number of workers. The long-wanted, leading idea or motive has been in large part furnished by the Periodic Law. The comparison of the chemical and physical properties of the elements and their compounds, the search for new elements, the fuller investigation of those already known, with the view of more firmly establishing their place in the system, and the redetermination of the atomic weights, are evidence of its influence. Witness, for example, the great activity in the subject of the rare earths, the work on the relative position of nickel and cobalt in the system, and the investigations of the atomic weight of tellurium, having for their object the decision of the question whether this element actually has an atomic weight greater than that of iodine, as the best determinations thus far seem to indicate, or whether it is less, as its chemical analogy to sulphur and selenium requires.

Organic chemistry, with its limited range of temperature, is essentially a chemistry of the beaker, the Liebig condenser and the bomb oven; it demands but comparatively simple and cheap apparatus of glass, not calculated to withstand high temperatures, and as such is within the means of the humblest laboratory. The reverence of the organic chemist for the platinum crucible is something astounding. With improvements in apparatus for producing and materials for resisting high temperatures, new vistas have opened to the inorganic chemist, while the province of the organic chemist, limited as it is by the instability of his compounds, has derived no benefit therefrom. Not only do we owe to this the beautiful investigations of Victor Meyer and others on high-temperature vapor densities, but with the recent development of electrical technology the electric furnace has appeared, and with it a new chemistry, the chemistry of a temperature of 3,500° C. Not only have new

compounds been made which cannot be produced at lower temperatures, but the accessibility of many elements and compounds has been greatly increased. The reductions which Wöhler and Deville effected gram-wise in glass and porcelain tubes can now be carried out in the electric furnace pound-wise and even ton-wise. The manipulation of the current for electrolytic purposes, rendered possible by increased knowledge of the laws of electricity, as well as by ease of its production, is yielding results chiefly in the domain of inorganic chemistry, while the organic chemist is but tardily utilizing the current as a means of oxidation and reduction. Besides the extraordinary development of electro-metallurgy, the preparation of soda and chlorates and other technical processes, the application of electricity to purposes of analysis and for the synthesis of new compounds, such as the rare metal alums, percarbonic and persulphuric acids, and the isolation of fluorine, may be mentioned.

Passing to the opposite extreme of temperature, we find the development of high-temperature chemistry accompanied by the growth of a chemistry of low temperatures. The very recent improvements in the art of producing cold have made liquid air a cheap material, and with its aid Ramsay has been able to fractionally distil liquefied argon and to separate from it the contaminating elements of the same group, neon and xenon, as well as krypton and met-argon.

The part played by the spectroscope in chemistry is more or less familiar to everyone. From the further development of the science of spectroscopy it is clear that inorganic chemistry has much to gain. Whether or not the view first suggested by Clarke and long defended by Lockyer be true, that the elements undergo partial decomposition in the stars and nebulae, it is upon this instrument that we must rely for our knowl-

edge of the high-temperature chemistry of these bodies, a chemistry which is wholly inorganic.

The rapid growth of these sciences into which chemistry enters is producing an ever increasing demand upon the chemist for new researches. While the biologist must rely mainly on the organic chemist for his chemical data, no less must the mineralogist and geologist appeal to the inorganic chemist for the solution of many problems in their field. The formation and decomposition of minerals, the disintegration of rocks, the behavior of rock magmas, the phenomena of metamorphism, of ore deposition and vein formation, the influence of high temperatures and pressures—all these afford problems the solution of which is hopeless without the assistance of inorganic chemistry either alone or aided by physical chemistry. The chemist who has to meet the inquiries of the geologist, and who must too often confess our ignorance of the causes of even the simplest phenomena, can not help feeling what a splendid field is here open, awaiting only the advent of workers suitably trained and of laboratories properly equipped for research in chemical geology. The demands of the geologists are unquestionably destined to be among the most potent factors in the revival of inorganic chemistry.

It is not to be expected, nor is it to be desired, that inorganic chemistry will at once sweep organic chemistry from its position of preëminence. The causes to which this is due may outlast our generation, but that the inorganic tide is rising, and that this branch will finally attain its due position, can not be doubted. The recent establishment of a *Zeitschrift für anorganische Chemie*, while it may be deplored as increasing the already too great number of chemical journals, and as tending to widen rather than diminish the gap between the organic and inorganic branches,

is helping to produce a feeling of solidarity among inorganic chemists which never existed hitherto. Even in Germany, the stronghold of organic chemistry, the address of van't Hoff is exciting wide interest, and the *Chemiker Zeitung*, in urging the establishment of independent chairs and laboratories of inorganic chemistry, is advocating what will in time unquestionably be realized.

Inorganic chemistry is fortunate in that its renaissance is coming about at a time when physical methods are in vogue. The prediction of Du Bois-Reymond is being realized; with the aid of physics it is attaining an insight into the dynamical aspect of the science which it could never have reached unassisted. But it is not alone by supplying new methods and suggesting new points of view that physics is aiding the revival of inorganic chemistry. Perhaps equally important is the fact that the rising school of physical chemists, unhampered by the traditions and limitations of organic chemistry, is finding it necessary to explore the whole range of the science in search of material for its investigations. The physical chemist is neither organic nor inorganic, or rather he is either, according to his requirements, but it is precisely because the inorganic field is wider and less developed than the organic that his demands are more likely to be productive of activity.

Energetics is now the basis of chemistry, and it is to be expected, therefore, that inorganic chemistry will not, in the future, have to pass through a period of arrested development and formula worship, such as have so long affected organic chemistry. There will always be compound makers, but their aim will be, not the establishment of constitutional formulas alone, but the study of the laws of chemical energy and the solution of the problem of the nature of matter. We may expect, too, that the still

sharp line of demarcation between inorganic and organic chemistry and between dead and living matter will disappear. The inorganic chemist may not affect the synthesis of a proteid, but he will be able, with his wider knowledge, to contribute more to the solution of the problem of the nature of life than any amount of structurizing and synthesizing alone can do. To comprehend life we must understand carbon, but we can no more fully comprehend carbon without an understanding of the other elements than we can explain the earth without a knowledge of the other planets, or man without a knowledge of the fish. He, then, who pursues inorganic chemistry is not only contributing to a higher development of our science than can be reached by the study of carbon compounds alone, but is perhaps doing as much as the organic chemist toward realizing one of the greatest aims of research, the comprehension of life and its explanation in terms of physical science.

WASHINGTON, D. C.

H. N. STOKES.

ON THE TOTAL SOLAR ECLIPSE OF
MAY 28, 1900.

THE next total solar eclipse will be visible as such in places both east and west of the Atlantic Ocean, and it is a matter of some thought to determine where it shall be observed. I have proposed to report to the governing board of Williams College that it is practicable to observe it on both sides at points to be fully determined later, as at present there is rather more than a year's time to make the needful arrangements.

The two countries where it shall be observed seem to be Portugal and our own Southern States, in the neighborhood of Coimbra and that of Norfolk, in Virginia, or perhaps farther south. The only doubt is the more or less uncertainty of weather. That, however, cannot be avoided, as the meteorologists are not yet able to predict with much certainty or at all for more

than a few days at a time. The Weather Bureaus at Washington and Lisbon will, of course, do all that they can, but the most that can now be done is to observe the weather in 1899, in the hope of getting some new light on the matter.

So far as the eclipse is concerned, which will certainly take place at the predicted time, it is possible and practicable to make calculations from the data in our American Ephemeris, and to do this within a few days, and in the coming months to make all needful preparations of instruments and training of observers, and with abundant spare time left.

I shall report to our trustees that the main effort to be made then will be towards photographing the eclipse as well and completely at both points as the time, short enough at best, will allow.

At Norfolk, in Virginia, and Ovár, in Portugal, the eclipse will be total long enough to be well photographed by instruments costing but little more than a hundred dollars for each station, instruments which can be made useful in several directions and can be readily placed at either station. The advantage of making the effort to observe at both places will be, of course, not that of making observations at the same time, but that of following out a uniform set of rules both in America and in Europe.

These rules can be readily formulated and practiced beforehand with comparatively little trouble, provided the astronomers can come to an agreement, which I think will be an easy matter.

The process of taking the photographs is so easy now that no difficulty will arise from this, and it will also be easy to train intelligent students into the necessary physical manipulations, with the help, at least, of the necessary photographers, who, I presume, will be readily brought to either station.

As the object of the present paper is merely to indicate what is to be done, I shall defer to another occasion any further details. In this, as in many other problems of practical astronomy, the main requirement is merely to indicate in common language the problems to be solved, and it will be sufficient to leave further consideration of the matter to another occasion.

TRUMAN HENRY SAFFORD.

RECEPTION AND EXHIBITION OF THE NEW YORK ACADEMY OF SCIENCES.

THE Annual Reception and Exhibition of the New York Academy of Sciences has come to be one of the most interesting social events of the scientific circles of the city. This fine spring weather and a beautifully suitable hall combined with the zeal of the exhibitors to furnish instructive entertainment to about three thousand persons. The reception was held, as usual, at the American Museum of Natural History, the first evening being reserved for members, exhibitors and special friends, and some 500 availed themselves of this opportunity to become better acquainted with their fellow members, and to see and discuss the advances in branches of science other than their own. Indeed, the justification and benefits of these exhibitions are to be sought quite as much in their broadening influence upon the point of view of specialists as in their possibilities for the layman and amateur.

The Museum authorities are exemplary in their hospitality, and the relations between this gigantic object lesson in science and the Academy are yearly growing more cordial. This year it was possible to hold the reception in the new hall of American Anthropology, west of the entrance on the main floor. The room is finished, but is not yet occupied by cases and permanent fixtures. A more suitable and appropriate location for a scientific reception it would be hard to imagine.

The General Committee in charge of the various sections were as follows :

Anatomy : Jos. S. Flake.
Astronomy : J. K. Rees.
Botany : C. C. Curtis.
Chemistry : Charles A. Doremus.
Electricity : Geo. F. Sever.
Ethnology and Archæology : L. Farrand.
Experimental Psychology : Chas. H. Judd.
Geology and Geography : J. F. Kemp and R. H. Cornish.
Mineralogy : A. J. Moses.
Paleontology : Gilbert van Ingen.
Photography : Cornelius Van Brunt.
Physics : C. C. Trowbridge.
Zoology : Gary N. Calkins.

While the display was not marked by any one prominent object, such as X-rays, still it was characterized by an excellent average of exhibits of sterling value, and should give its visitors an illustration of scientific interest as distinct from the spectacular.

It would, of course, be too prolix to attempt to give anything more than a few of the typical objects enumerated in the catalogue of some twenty pages.

The exhibit in Anatomy, though small in space, contained examples of most interesting points. The variations in the vermiform appendix, in the hepatic artery, etc.

The Harvard, Lick and Yerkes Observatories joined with that of Columbia in making the department of astronomy thoroughly representative of the recent interesting advances in that subject. Saturn's new moon, the new planet Eros, the rotation of the sun as shown in the Johns Hopkins spectra, the variation of latitude, vied with one another for popular favor.

The Bronx Park Botanical Garden contributed much interesting material to the Section of Botany, which contained some twenty titles.

In Chemistry popular interest seemed about equally divided between Munroe's illustrations of the effects of dynamite,

smokeless powder and phenyldimethylpyrazolonesulphonates.

Ethnology showed Eskimo property marks, British Columbia baskets, a new hieroglyphic writing from Mexico, and other objects of almost equal interest.

Photometry, illusions, binocular rivalry, accuracy of movement and endurance were the objects of measurements in psychology.

Under Geology and Geography were shown recent work of the U. S. Geological Survey, the Maryland and the New York State Surveys, including the Geologic model of the Yellowstone National Park made by the U. S. Geological Survey to go to the Paris Exposition, and a relief map of the Adirondack Region made by Merrill. A suite of crude petroleums and several others of interesting rocks, together with large thin sections (three inches square) of rocks, furnished interesting material for the geologist and petrographer.

Mineralogy made a bewildering display of beautiful and interesting minerals and apparatus, with examples of photo-micrographs and photographs with uranium rays.

Physics presented grating spectra from Johns Hopkins, illustrating rotation of sun, effect of pressure upon the arc spectra, Zeeman effect and coincidence of metallic and Fraunhofer lines, special colorimeters, distillation apparatus, Crookes tubes, abbreviated continuous mercury vacuum pumps, a special arc light and audimeter, the effect of an alternating magnetic field upon a lamp filament, line screens for color photography, a complete set of apparatus for research in Hertz waves and wireless telegraphy, a low resistance and a standard-comparison Wheatstone bridge, apparatus used in measuring specific heat and temperature at mines 200 degrees Centigrade, also the new Dudley strematograph with results of its use in measuring stresses in railroad rails under moving trains.

Among many interesting exhibits in Pale-

ontology the magnificent limbs of four monstrous dinosaurs commanded special attention.

Similarly in Zoology the beautiful new case illustrating the nesting habits of the brown pelican rather out ran in popular favor other objects of great scientific interest.

As may be inferred even from the above brief and unsatisfactory sketch, the exhibition was as wide in its scope as it was scientifically interesting in its details. It must have been seen to be appreciated, and the thanks of those who did see it are due to the zeal of the exhibitors, especially those out of town, among whom should be mentioned Princeton, Harvard, Johns Hopkins and Chicago Universities, Lick and Yerkes Observatories, the United States, Maryland and New York Surveys.

WILLIAM HALLOCK,
Chairman of Committee.

SCIENTIFIC BOOKS.

Lectures on the Evolution of Plants. By DOUGLAS HOUGHTON CAMPBELL, PH.D., Professor of Botany in the Leland Stanford Junior University. New York, The Macmillan Company. 1899. 12mo. Pp. viii + 319.

Professor Campbell is probably the foremost of the small group of what may be termed the philosophical botanists in America, and he is, no doubt, better prepared to discuss the questions taken up in this book, at least in so far as they deal with the archegoniates and seed plants, than any other of our students of plants. Some years ago he brought out his book 'The Structure and Development of the Mosses and Ferns,' in which he treated the subject in such a modern way as to give new meaning to what had to too great a degree been mere dry detail. In no uncertain words he traced the genetic relationship of group to group, and the student following him was made to feel that the fact of relationship was real and necessary, and not doubtful or shadowy.

In the little book before us the author discusses, in succession, the conditions of plant

life, the simplest forms of life, algæ, fungi, mosses and liverworts, ferns, horsetails and club-mosses, gymnosperms, monocotyledons, dicotyledons, geological and geographical distribution, animals and plants, influence of environment, and at the end brings together his results in a chapter entitled 'summary and conclusions.'

We can do no better in endeavoring to give our readers an idea of the author's treatment and conclusions than to quote a sentence here and there from his final chapter, as follows: "All plants agree closely in their essential cell structure, the typical cell having a cellulose membrane and a single nucleus." "The lowest plants are mainly aquatic, and it is exceedingly probable that this is the primitive condition of plant life." "The peculiar group of motile green algæ, the Volvocineæ, probably represents more nearly than any existing forms the ancestral type of all the higher green plants. These ciliated algæ are also probably related to certain colorless flagellate Infusoria, which in turn may represent the starting-point for the whole group of Metazoa among animals. It is not unlikely that the separation of the two great branches of organisms, plants and animals, took place among the Flagellata." "Starting with this primitive motile unicellular organism, there have evidently arisen a number of independent lines of development resulting in very divergent types of structure." "In these lowly organisms there is no clearly marked line between vegetative and reproductive cells."

"The increasing complexity of the plant body has been accompanied by a corresponding specialization of the reproductive parts." "The origin of the Phæophyceæ, or brown algæ, from free-swimming brown flagellate organisms, is by no means unlikely, and if this be shown to be the case they must be considered as a line of development parallel with the Chlorophyceæ, rather than an off-shoot from these." "The relationship of the fungi is still an open question." "The ancestors of the higher green plants must be sought among the simple fresh-water green algæ. The genus *Coleochaete*, the most specialized of the Confervaceæ, is the form which shows the nearest analogy with the lower

Bryophytes." "In the mosses * * the persistence of the motile spermatozoid indicates the derivation of the Archegoniates from aquatic ancestors." "The Pteridophytes, also, show traces of an aquatic ancestry in the development of spermatozoids, which require water in order that they may reach the archegonium."

"Of the Spermatophytes the Gymnosperms are obviously the lowest types, *i. e.*, they show more clearly their derivation from the Pteridophytes." "The Angiosperms are preeminently the modern plant type. These have largely crowded out the other earlier types of vegetation, and at present comprise a majority of existing species." "It is among the Angiosperms that the plant body reaches its highest expression. In the keen struggle for existence among the manifold forms of plants the Angiosperms have shown themselves to be extraordinarily plastic, and have developed every possible device to enable them to survive this fierce competition."

We need quote no more from this very suggestive and very readable book. Every botanist and every earnest botanical student will read it with interest and profit.

CHARLES E. BESSEY.

THE UNIVERSITY OF NEBRASKA.

Die Spiele der Menschen. Von KARL GROOS.
Jena. 1899.

Professor Groos follows up his work on Animal Play with his promised book on Human Play. He divides this last work into two sections, the first discussing the facts of play under headings, Touch Plays, Temperature, Hearing, Sight, Motor Plays of various kinds, and purely psychic plays; the second, discussing theories of play under headings, Physiological, Biological, Psychological, Æsthetic, Sociological and Pedagogical. The general grouping of facts is, as regards biological results, into activities which serve as exercise and those which serve as display in impressing others—that is in the two divisions, where individual significance is dominant, or social significance. Of course, this is a quite objective classification; the child not consciously taking exercise—this being really work—but continuing the activity for its immediate pleasurable-

ness. The showing-off play is largely consciously such; there is here more of the subjective and teleological factor.

Under Hearing and Sight Plays Professor Groos is quite full and interesting, really giving in outline the evolution of these senses in the race and individual. We might ask why he divides Hearing Play into passive and active, and not other sense plays. The child is, indeed, diverted either by your singing, or by his singing to himself, but also both by your passing things before his eyes and himself passing things before his own eyes. Later he both looks at pictures in books and draws pictures for himself. Indeed, it is plain that gratification of any sense may be either active or passive, the active side leading off into art activity and art work.

Professor Groos's account of Motor Plays is hardly as full and satisfactory as that on Sense Plays. We find here, as elsewhere, too often a heaping-up of facts and of quotations with very cursory interpretation. Thus (p. 95) he rather hastily lumps the American habit of gum chewing with betel-chewing, and with the habit of chewing bits of sticks and grass, as motor plays for jaws and tongue. But while it is plain that the gum-chewer may use a piece of gum as a mouth-plaything, yet to a large extent gum chewing is merely a morbid nervous habit, or a means of gratifying sense of taste, and in both these ways not play. So also the athlete who chews gum or other articles during a football game is not in this playing. Chewing is only play when it is chewing for chewing's sake, and not as a mere relief from nervous tension, or for taste pleasure or to help endurance and grit.

Professor Groos rightly regards the psychological mark of play not as imitation, but as direct pleasurable-ness. The mere biological activity comes first as outcome of bare physiological impulse; thus the infant grasping indefinitely feels something soft, experiences pleasure and keeps handling the object. Objectively and biologically all this activity is play, but psychologically only the later half (p. 95). As to physiology, "Es sind zwei Hauptprincipien, die eine psychologische Theorie des Spiels beherrschen müssen, das der Entladung über-

schüssiger Kräfte und das der activen Erholung erschöpfter Kräfte." The æsthetic social point of view is enlarged on throughout much in the same way as in his previous work.

In general the remarks we have made on Professor Groos's previous work (*Psychological Review*, Vol. 6, p. 86 ff.) apply also to this. The last book is larger, fuller and more cautious, but it lacks in clearness and directness and penetration. Though sometimes suggestive, it is rarely illuminating. Very comprehensive and learned, it is useful as a summary and discussion, but it has not the vitality of real research. The book is swamped in quotation, and we have more a history and discussion of opinion than a first-hand investigation. Though by bringing in everything of the least relevancy Professor Groos attains a certain completeness, it is greatly to be doubted whether in breaking ground in a new subject this is the most useful method. The foundations for a real science of play can only be laid by the direct detailed study of the life-history of the individual, the results being made to an extent verifiable by the photograph and phonograph.

HIRAM M. STANLEY.

BOOKS RECEIVED.

The Elements of Practical Astronomy. W. W. CAMPBELL. New York and London, The Macmillan Company. 1899. Pp. xii + 264. \$2.00.

Nature Study for Grammar Grades. WILBUR S. JACKMAN. New York and London, The Macmillan Company. 1899. Pp. 407. \$1.00.

The Fairyland of Science. ARABELLA B. BUCKLEY. New York, D. Appleton & Co. 1899. Pp. x + 252. \$1.50.

Electricity in Town and Country Houses. PERCY E. SCRUTTON. Westminster, Archibald Constable & Co. 1899. 2d Edition. Pp. xii + 148.

Report of the Commissioner of the United States Commission of Fish and Fisheries. Pp. clxxv + 350.

Corn Plants. F. L. SARGENT. Boston and New York, Houghton, Mifflin & Co. 1899. Pp. 106. 75 cts.

Anglo-American Pottery. E. A. BARBER. Indianapolis, Ind., Press of the Clay Worker. 1899. Pp. xix + 161.

Photographic Optics. R. S. COLE. New York, D. Van Nostrand Company. 1899. Pp. 330.

SCIENTIFIC JOURNALS AND ARTICLES.

The Botanical Gazette for April contains the following leading articles: 'A Conspectus of the Genus *Lilium*,' by F. A. Waugh, which brings together and organizes the widely scattered material; 'Some Appliances for Elementary Study of Plant Physiology,' by W. F. Ganong, in which are described, with figures, a temperature stage, a clinostat, a self-recording auxanometer, an osmometer, a respiration apparatus, a germination box, a transpiration device, the graduation of roots, tubes, etc., and a root-pressure gauge; 'Oogenesis in *Pinus Laricio*,' by Charles J. Chamberlain, a paper with plates, in which the following results are announced: The ventral canal cell occasionally develops as an egg; the chromatin of the egg nucleus takes the form of nucleoli which finally collect from all parts of the nucleus to a definite area near the center and there develop into a typical spirem; the chromatin of the two sexual nuclei is in the spirem stage at fusion; the fate of the spindle indicates that the kinoplasmic fibers arise through a transformation of the cytoplasmic reticulum; a continuation of 'The Ecological Relations of the Vegetation of the Sand Dunes of Lake Michigan,' by Henry C. Cowles, the present part, profusely illustrated, discussing the encroachment on preexisting plant societies and the capture of the dune-complex by vegetation. Under 'Briefer Articles' Julia W. Snow describes (with plate) the life history of a new *Ulvella* (*U. Americana*), and Bradley M. Davis discusses recent work on the life history of the Rhodophyceæ. The number closes with the usual reviews, notes for students and news.

American Chemical Journal, April, 1899. 'On the Hydrolysis of Acid Amides:' By I. Remsen and E. E. Reid. The rate of hydrolysis of a large number of acid amides was compared and certain groups or positions of groups were found to exercise a marked influence on the reaction. In general the results agree with those obtained in the study of the rate of formation of ethereal salts. Ortho groups were found to exert a very marked 'protective' influence in many cases. 'Aliphatic Sulphonic Acids:' By E. P. Kohler. The author describes the preparation and reaction of (1) brome-

thylene sulphonie acid and its derivatives. 'A Serviceable Generator for Hydrogen Sulphide.' By W. P. Bradley. This generator is so arranged that all the acid is used, and it only needs filling several times a year. The iron salt formed does not mix with the acid, but is drawn off and thrown away.

J. ELLIOTT GILPIN.

SOCIETIES AND ACADEMIES.

THE NATIONAL ACADEMY OF SCIENCES.

THE annual stated meeting of the National Academy of Sciences was held at Columbian University beginning Tuesday, April 18th, and ending Thursday, April 20th. The members missed the rooms to which they were so long accustomed in the National Museum, but the growth of this institution has been so marked that there is no longer any room available for such purposes. A committee has been appointed to secure, if possible, permanent quarters, and it is hoped that, in view of the relations of the Academy to the United States government, rooms may be set aside in some public building for the use of the Academy.

The papers presented at the public sessions were as follows :

1. *Ophiura Brevispina*, W. K. Brooks and Caswell Grave.
2. The Shadow of a Plant, A. Hall.
3. On the Tanner Deep Sea Tow Net, A. Agassiz.
4. On the Acalephs of the East Coast of the United States, A. Agassiz and A. G. Mayer.
5. On the Limestones of Fiji, E. C. Andrews ; communicated by A. Agassiz.
6. On the Bololo of Fiji and Samoa, W. McM. Woodworth ; communicated by A. Agassiz.
7. On the Diamond and Gold Mines of South Africa, A. Agassiz.
8. Progress in Surveying and Protection of the U. S. Forest Reserves, Chas. D. Walcott.
9. The Resulting Differences between the Astronomic and Geodetic Latitudes and Longitudes in the Triangulation along the Thirty-ninth Parallel, H. S. Pritchett ; introduced by Chas. D. Walcott.
10. The Work of the Division of Forestry, Department of Agriculture, Gifford Pinchot ; introduced by Chas. D. Walcott.
11. On the Development by Selection of Supernumerary Mamme in Sheep, A. Graham Bell.
12. On Kites with Radial Wings, A. Graham Bell.

13. Remarks on the Work of the Nautical Almanac During the Years 1877-98 in the Field of Theoretical Astronomy, S. Newcomb.

14. Exhibition of Specimens of *Nautilus pompilius*, W. K. Brooks and L. E. Griffin.

The new members elected are : Professor C. E. Beecher, Yale University ; Professor George C. Comstock, University of Wisconsin ; Professor Theodore W. Richards, Harvard University ; Professor Edgar F. Smith, University of Pennsylvania, and Professor E. B. Wilson, Columbia University.

The Academy adjourned to meet in New York next November.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 499th meeting of the Society was held at 8 p. m., April 1st, in the assembly room of the Cosmos Club. The first paper was by Mr. G. W. Littlehales on 'The Prospective Place of the Solar Azimuth Tables in the Problem of Accelerating Ocean Transit.' A brief abstract of this paper will appear later in SCIENCE. The second paper was by Mr. E. G. Fisher on 'Data Relating to Nickel Iron Alloy.' The third paper was by Mr. H. A. Hazen on 'Electric and Magnetic Weather.' Mr. Hazen said in part :

One of the earliest coincidences between the weather and magnetism was published in a set of curves in the Annual Report of the C. S. O. for 1882, showing the exact correspondence between the curves of diurnal range of magnetic declination and pressure of the air. In April, 1898, a period of 25.912 days was found from temperatures for 20 years at Omaha, Neb., and this period applied to the annual observations in the United States from 1870 to 1898 (about 400 occurrences) showed a marked maximum point on one day throughout. The largest number of auroras observed in any one day in the United States fell upon this same day (not included, however, in the count). In February, 1899, Dr. Ekholm sent a paper in which he had established a period of 25.92876 days from observations of the auroras in Sweden for 175 years. This period, applied to the above observations, gave almost a straight line. The great danger of using the twenty-four-hour change in any element was pointed out. It was shown

that there was almost an exact accordance between the diurnal range in magnetic declination, horizontal and vertical form. When the fluctuations in these elements from day to day were compared, however, there were remarkable periods of coincidence, combined with non-coincidence. It was shown that the curves for grains in a cubic foot of air and for pressure fluctuations were exactly coincident at St. Louis, Mo. When these curves were compared with the magnetic curves there was no difficulty found in matching them with one or another of the latter. This seemed to show an intimate connection between the phenomena, and it now remains for those versed in terrestrial magnetism to explain the want of coincidence in the phenomena.

E. D. PRESTON,
Secretary.

GEOLOGICAL SOCIETY OF WASHINGTON.

At the regular meeting of this Society, held in Washington, D. C., on April 12, 1899, Mr. Alfred H. Brooks communicated some 'Notes on the Geology of the Tanana and White River Basins, Alaska.'

The region embraces the Lower White and the major part of the Tanana River, both tributary to the Yukon. To the south the area is bounded by a part of the St. Elias range, by the Natzutin Mountains and by the Alaskan range, and lies chiefly in the region of the dissected Yukon plateau.

A complex of gneisses, gneissoid and massive granites, with some dioritic rocks, are believed to be the basal series. They are succeeded by metamorphic rocks which have been differentiated into three groups. These are unconformably overlaid by the Wellesley formation, consisting chiefly of conglomerate, of Devonian or Carboniferous age. On the Lower Tanana some sandstone and slate beds were noted and called the Nilkoka beds, and these are probably also Paleozoic. These have all suffered considerable deformation and often carry mineralized quartz veins. In the older and more altered rocks the quartz is more plentiful than in the younger beds. Assays of a number of samples gave traces of both gold and silver. A small area of very slightly deformed soft yellow sandstone was tentatively classed as Eocene.

The position of two systems of structure lines goes to show that the deformation of the region was caused by two synchronous thrusts coming from different directions, and these were probably lines of movement during several periods of deformation.

The summits of the old plateau remnants are a striking feature of the region and mark an old peneplain. During the late Tertiary time this peneplain was elevated and probably somewhat deformed and was then deeply dissected. The evidence goes to show that the drainage of the upper Tanana and middle White then flowed southeast and probably found its way to Lynn Canal by way of the valleys of the Nissiling, upper Alsek and Chilkat Rivers. A depression succeeded the uplift, and the partially drowned valleys were then filled with sediments. Toward the close of this period of depression the White River Valley was occupied by ice, and probably a little later glaciers moved down some of the southern tributaries of the Tanana. No evidence of general glaciation was found in the region. The last orographic disturbance was the elevation of the land mass to about its present position, and this caused a partial dissection and terracing of the sediment of the older valleys.

Mr. J. S. Diller exhibited specimens of *Paleotrochis* which had been described in 1856 by E. Emmons as siliceous corals and regarded as the oldest fossils known. Professor James Hall regarded them as concretions. Professor J. A. Holmes, of North Carolina, examined the rock in the field and considered it of igneous origin, while Mr. C. H. White, who examined the specimens collected by Holmes, pronounced the forms organic. Nitze and Hanna, of the Geological Survey of North Carolina, maintain the igneous characters of the rock, and this view is strongly supported by Mr. Diller, who showed that the supposed fossils and concretions are spherulites in a more or less altered rhyolite. Mr. Diller's paper will be published in full in the *American Journal of Science*.

W. F. MORSELL.

U. S. GEOLOGICAL SURVEY.

CHEMICAL SOCIETY OF WASHINGTON.

THE regular meeting was held on March 9, 1899.

The first paper of the evening was read by Dr. F. K. Cameron and was entitled 'Acetone-Chloroform, 2d paper,' by F. K. Cameron and L. J. Briggs.

The second paper was read by Mr. T. H. Means and was entitled 'Estimation of the Salt Contents of Soil Waters,' by T. H. Means and F. K. Cameron. This method has been devised for a rapid estimation of the relative proportions of chloride, sulfates and carbonates in the 'alkali' soils of the Western districts. It is used as a check upon the electrical method for the determination of the soluble salt content of soils, as well as to furnish approximate analyses in the field without waiting for complete analyses to be made in the laboratory. The method determines chlorides, sulfates and carbonates in terms of the sodium salt. A sample of water is taken, or an extract is made of the soil, and the solution filtered or decanted. The solution need not be clear. An excess of barium nitrate (10 cc.) is added to 10 cc. of the soil extract, thus precipitating sulfates and carbonates. The excess of barium nitrate is titrated back with potassium chromate, using silver nitrate on a porcelain plate as an indicator. In the same vessel silver nitrate is added, using potassium chromate on the plate as an indicator, thus precipitating the chloride. A few drops of nitric acid are now added and the liquid heated, driving off the carbon dioxide from the barium carbonate. The excess of nitric acid is neutralized by powdered magnesium carbonate. Again the solution is titrated with potassium chromate, the quantity required giving the amount of carbonates. This subtracted from the sum of the sulfates and carbonates, as found above, gives the sulfates. This method makes the three titrations in one vessel, the apparatus being of such a simple nature that all can be carried in a camping outfit.

The third paper was read by Mr. J. K. Haywood and was entitled 'The Determination of Calcium and Magnesium in Ashes.' The author has found that in determining calcium and magnesium it is not essential to wash the voluminous ppt. of basic acetate of iron and phosphate of iron, but that results of almost equal accuracy are obtained by making the precipita-

tion in a 500-cc. flask, filling up to the mark, passing through a dry filter and using aliquot portions of the filtrate for analysis. The above is substantiated by experimental data.

The last paper was read by Dr. H. C. Bolton and was entitled 'The Classification of Chemistry Proposed by the International Catalogue Committee of the Royal Society, a Critical Analysis,' by W. P. Cutter and H. C. Bolton. The paper analyzed the proposed scheme of classification of chemical titles drawn up by the Committee on the International Catalogue of the Royal Society. It characterized the system as conglomerate, since numbers, Roman capitals, lower case, italic letters and Greek letters are mixed up with alphabetical headings. The system embraces also methods of notation which are very objectionable, inasmuch as the symbols are analogous in structure and appearance to chemical formulæ, yet they are essentially different. The scheme proposed, if intended to facilitate research, is pronounced by the authors of the analysis an almost total failure.

WM. H. KRUG,
Secretary.

THE MINNESOTA ACADEMY OF NATURAL SCIENCES.

At the regular monthly meeting of April 4th three papers of general interest were presented. Dr. F. W. Sardeson discussed the primitive structure of the Crinoid stem. Specimens were exhibited showing the manner of development from the first Cystidean type of structure, *i. e.*, an elongation of the body wall supported by hexagonal plates; the arrangement into five vertical rows of the alternating transversely elongated six-sided plates; the arrangement of these plates in transverse circles forming distinct sections and joints, this being the most primitive structure of the stem seen in the Crinoidea; the circle of five plates in each section united in such manner as to form a solid ring with a central pentagonal perforation or canal.

Dr. U. S. Grant described a driftless area in northeastern Minnesota. The area in question is a small one, 8 by 12 miles, around Wilder Lake, entirely free from the drift which covers the country around it so deeply. The rock

surface is decayed as if no removal or grinding of the surface material had taken place by glacial action, and is entirely free from drift boulders. As a probable explanation the author suggested that this area lay to leeward of a great ice ridge which effectually shielded it from the direct action of the glacial ice stream.

Mr. H. B. Humphrey detailed his observations upon the influence of low temperatures upon plants, and described the difference of effect of sudden changes and gradual lowering of the temperature. Living specimens kept for a month or more in commercial cold-storage rooms at a point slightly below freezing exhibited phenomena of starvation.

CHARLES P. BERKEY,
Corresponding Secretary.

MINNEAPOLIS, MINN.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

At the meeting of the Academy of Science of St. Louis of April 3d a paper by Mr. Stuart Weller, entitled 'Kinderhook Faunal Studies, I: The Fauna of the Vermicular Sandstone at Northview, Webster county, Mo.,' was presented for publication; and Mr. Trelease exhibited a plaster cast of a gigantic monstrosity of *Cereus marginatus*, known as the Rosa de Organo, presented to the Missouri Botanical Garden by Professor Frederick Starr, and reported that this formation was locally abundant at points south from Aguas Calientes. The speaker exhibited a large number of comparable cactus monstrosities from the plant-houses of the Missouri Botanical Garden and the collection of the President of the Cactus Association of St. Louis, and a similar deformity of one of the cactus-like Euphorbias of the African region, commenting on this teratological type. It was shown that for the purposes of gardeners, for whom these unusual forms appear to possess a considerable interest, they are commonly divided into two types, in one of which, commonly designated by the varietal name *cristata* or *cristatus*, the monstrosity takes the form of a fan or a contorted ridge, while in the other, commonly designated by the varietal name *monstrosa* or *monstrosus*, it consists of irregular bunching of the branches and an interrup-

tion of the customary longitudinal ridges of such a genus as *Cereus*.

WILLIAM TRELEASE,
Recording Secretary.

BOSTON SOCIETY OF NATURAL HISTORY.

A GENERAL meeting was held March 15th; twenty-eight persons present.

Mr. E. C. Jeffrey, in an account of the genus *Equisetum*, stated briefly the sexual and asexual methods of development. The internal structure of the stem was described, and the relationships of the Equisetæ to the Lycopods and ferns were noted. Structurally *Archæocalamites* resembles the higher Lycopods. The branches of *Calamites* originate from the center of the ring of nodal wood or from its lower border. Casts of *Calamites* show pith.

Dr. C. R. Eastman read a paper on some new North American fossil fishes. An abstract will appear in an early number of SCIENCE.

SAMUEL HENSHAW,
Secretary.

DISCUSSION AND CORRESPONDENCE.

ON THE ACTION OF THE COHERER.

EXPERIMENTS have been made at the physical laboratory of the Missouri State University which show that the action of the Branly tube is due to an actual cohering of the particles. The action consists, first, in an electrostatic attraction causing the particles to come in contact, and, second, in a fusion of the points of contact.

An instrument has been designed and constructed which clearly shows this coherence and renders its study possible. It consists of two electrodes, one a metallic plate on which the filings are placed, and the other a metallic point carried on a pivoted arm swinging in a vertical plane. If a considerable difference of potential is maintained between these electrodes, and the point be brought in contact with the filings and then carefully lifted, a thread will attach itself to the point and may be drawn out to two or more inches in length. The difference of potential has, in our experiments, been produced in a variety of ways. Thus the instrument was placed in circuit with two dry cells and a 160-ohm relay, and threads

produced. Here the effect was caused, not by the low potential of the battery current, but by the much higher potential of the extra current produced by the constant breaks at the lower end of the thread. This was demonstrated by placing a non-inductive resistance of about 1,000 ohms in parallel with the coherer. This entirely prevented the action. Attaching the ends of the secondary of an induction coil to the coherer gave similar results, as did also the Holtz machine.

But these threads remained cohering after there had ceased to be a difference of potential between the electrodes. In a vacuum the threads still remained hanging, showing that the friction and pressure of the air did not maintain the coherence. Under the microscope the points of contact appear to be fused, and other observers have noticed bright points after coherence is destroyed. That fusion occurs is also shown by the fact that metals having a high melting point give threads of much less tenacity than those with low melting points. Thus platinum and iron give very fragile threads, while tin, lead and aluminum give threads capable of enduring considerable flexure.

With the Holtz machine threads could be produced only when the machine was run slowly. If it was run too fast the particles would fly back and forth between the electrodes of the coherer. The point of the coherer, becoming charged, induces a charge in the particle nearest to it. This causes an electrostatic attraction, the particle flies to the point and, receiving a like charge, is at once repelled. But the instant it comes in contact the points of contact fuse, and if the charge on the electrode be small this fusion will be sufficient to resist the tendency to fly off and the filing will remain, becoming a part of the electrode and repeating the action on the next particle. Thus consecutive filings are united and a continuous thread of filings fused together, which connects the electrodes, reducing the resistance greatly. In a Hertzian field the action is precisely similar, the difference of potential here being produced by the action of the Hertz waves. Short threads of filings were obtained, as in the preceding experiments.

These experiments show that the great re-

duction in the resistance of the tube is due to the formation of continuous threads of metal connecting the electrodes. They also indicate some of the points which a good coherer must possess. The filings used should be composed of metal not easily oxidized, of small specific gravity and low melting point. The electrodes should consist of points or roughened surfaces of similar metal. Further, it is difficult to decohere a thread while a current is flowing, since the induced current at any break tends to bring back the parts to coherence. Marconi avoids this action by the use of a high resistance in parallel with the coherer. The necessity for this resistance can be avoided by having the current through the coherer broken before the tapping occurs. Experiments are being continued in the direction of a practical application of these principles.

M. H. LOCKWOOD,
E. B. WHEELER.

MARCH 30, 1899.

TWO-HEADED SNAKES.

TO THE EDITOR OF SCIENCE: I am engaged in the study and description of two-headed snakes by means of skiagraphy. Although I have in hand eight specimens from various museums, I have been unable to locate the *Tropidonotus* from the Massachusetts State Collection, described by Wyman in the *Proc. Bost. Soc. Nat. Hist.*, Vol. IX., p. 193, and the three snakes described by Mitchell in the *Amer. Jour. of Science*, Vol. X., p. 48.

I write in the hope that one of your readers may be able to help me in my quest of these four specimens, and that I may be informed of any other snakes with this abnormality in American collections, in order that I may make note of, or describe, them in my forthcoming paper.

ROSWELL H. JOHNSON.

1727 CAMBRIDGE STREET, CAMBRIDGE, MASS.,
April 14, 1899.

DUPLICATION OF GEOLOGIC FORMATION NAMES.

IT was not my intention, in my letter in SCIENCE of March 31st, to discuss the question as to whether certain names of geologic formations conflicted, or to discuss the undesirability of

using names that have more or less similarity. Its purpose, as stated, was 'to illustrate what the present system is leading to.' Names of formations and dates of publication were given for this purpose.

However, Director G. M. Dawson, in his recent communication in *SCIENCE*, states that it is not apparent from my remarks that Cache Creek group of formation holds priority. I do not see how any other construction can be given to the third paragraph of my letter. It is there briefly shown that Dr. Selwyn described the Upper and Lower Cache Creek group in 1872, and that in 1896 Dawson applied the name Cache Creek formation to both series. It is further evident, from the names and dates given, that the Cache Creek group has priority over either Cache Valley group or Cache Lake beds.

F. B. WEEKS.

U. S. GEOLOGICAL SURVEY,
WASHINGTON, D. C.

NOTES ON INORGANIC CHEMISTRY.

At the meeting of the Chemical Society (London) on March 16th Professor Dewar presented a paper on the boiling point of hydrogen, which is printed in the *Proceedings*. In obtaining liquid hydrogen great difficulty is experienced owing to the presence of small traces of air. Quantities amounting to only one thousandth of one per cent. accumulate in the solid state and eventually choke the nozzle of the apparatus, necessitating the abandonment of the operation. Dewar obtained 250 cubic centimeters of colorless liquid hydrogen and used this for the determination of the boiling point. His previous observations, using a platinum resistance thermometer, gave the boiling point as -238° . In these latest experiments a possible constant error in the use of the platinum thermometers was checked by using a rhodium-platinum resistance thermometer, the alloy containing ten per cent. rhodium. Examination had shown that alloys, unlike pure metals, showed no sign of becoming perfect conductors at absolute zero. The rhodium-platinum thermometer gave the boiling point of hydrogen as -246° , and this the author considers to be more accurate than the previous determinations, especially as it agrees very fairly with the boil-

ing point calculated from the results of Wróblewski and of Olszewski.

In an addendum dated March 17th Dewar gives the first results from a constant-volume hydrogen thermometer working under diminished pressure. This gave -252° as the boiling point of hydrogen. The three results in absolute temperature are: (1) platinum resistance thermometer, 35° ; (2) rhodium-platinum resistance thermometer, 27° ; (3) hydrogen thermometer, 21° . From this Dewar states that it appears that the boiling point of hydrogen is really lower than was anticipated.

In the *Journal of the Society of Chemical Industry* the use of titanium compounds in the dyeing industry is discussed, and it is shown that in many cases they may be successfully utilized. Especially are they valuable as mordants for alizarin yellows and oranges, and for basic dyestuffs. The tannate is not unstable towards acids and little influenced by light, and according to the author is valuable as a water-color. As experiments progress it is by no means impossible that many of the elements which now have little or no practical value may find uses, and work along this line offers much prospect of success.

In the last number of the *Zeitschrift für anorganische Chemie*, Piccini publishes the full details of the preparation of cesium manganese alum and a complete description of the salt. This is of more than passing interest from the fact that it is the first salt of trivalent manganese whose constitution is not open to question. Manganese alums are described in older chemical literature, but efforts to repeat their preparation have not been successful. By utilizing the electric current to oxidize manganese sulfate, Piccini forms the alum without difficulty, and in crystals large enough for a complete crystallographic study. It is thus settled that in manganic compounds the manganese is trivalent, and hence allied to aluminum, chromium and iron. From a private communication I learn that other manganese alums have been prepared and studied by Professor Christensen, and will shortly be described.

J. L. H.

CURRENT NOTES ON METEOROLOGY.

FROST PREDICTION AND PROTECTION.

BULLETIN No. 23 of the Weather Bureau is entitled *Frost: When to Expect it and How to Lessen the Injury Therefrom*, and is by Professor W. H. Hammon, Local Forecast Official at San Francisco. This paper is a revision of one prepared three years ago, and is the result of careful study extending over a long period. The *Bulletin* classifies the different methods of frost protection under five heads. Of these the most important ones are as follows: I., diminishing radiation; II., raising the dew point of the air, and, III., increasing the temperature of the air. Under the first class come screens of various kinds, such as glass, cloth or laths; and the well-known 'smudges.' The raising of the dew point is accomplished by burning damp 'smudges;' by evaporation from water tanks heated by fires; by spraying and by irrigating at times of frost, etc. The heating of the air by means of small fires, scattered about through the orchard or over the field, has also been found a very effective protector against frost in the drier parts of California. Among the various ingenious devices cited by Professor Hammon, the following is worthy of note. The machine, designed by Mr. George F. Ditzler, of Biggs, Cal., consists of a large, deep, sheet-iron tank, three or four feet square, mounted on a truck. About six inches from the bottom of the tank a wire grate is erected. Through a hole in the bottom of the tank, beneath the screen, a blast of air is admitted, which is produced by a revolving fan, operated by a sprocket chain and wheel attached to the wheel of the truck. A water cask and force pump, operated by the movement of the wagon, complete the outfit. A little tar or other fuel is placed upon the grate and ignited, and the tank is filled with wet straw or manure. When the machine is put in motion the blast produced by the fan causes an intense fire. All the heat of the fire has to pass through three feet of wet straw before it can reach the air. Thus evaporation is very active, and the vapor, rising from the wet material, immediately condenses, forming a dense fog or mist. While the machine is in motion, being driven forward and back between the

rows of trees in the orchard, water is continually pumped from the cask and discharged from small holes about the top of the tank upon the fuel. One such machine is said to evaporate 100 gallons of water an hour. The fog thus formed is stated to be so dense that the driver has frequently to go ahead and lead the horses.

A FOG DISPELLER.

WHILE the *production* of fog, as a means of protection against frost, is an extremely desirable thing in some districts on land, the possibility of *dispelling* fog over the oceans is another matter which is no less anxiously sought for. The following account of the so-called *Tugrin Fog Dispeller* is found in the *Monthly Weather Review* for January. The apparatus consists of an outlook pipe, eight feet long and three inches inside diameter, with a wide flange at the mouth, placed so as to be convenient to the navigating officer. A tube enters the pipe from below, and a blower sends a powerful stream of warm air through the tube and the pipe straight ahead, blowing a hole right through the fog, which is rolled back in every direction. It is said that the navigating officer is thus enabled to see through the densest fog for several hundred feet.

NOTES.

THE report of the Meteorological Council to the Royal Society for the year ending March 31, 1898, shows that of the 8:30 p. m. forecasts issued daily the percentage of verification was 81. Fifty-five per cent. of these forecasts were fully verified, and 26 per cent. were partly verified. The highest percentage of verification attained during the decade 1888-1897 was 84, in 1893. Of the storm warnings issued during the past year, 91.8 per cent. were justified by subsequent gales or strong winds.

THE progress of the investigation of the free air by means of kites continues. From the *Monthly Weather Review* for January it is learned that a kite corps has been formed at Bayonne, N. J., and that nearly 40 ascents were made between April and December of last year. The altitudes reached were in most cases not above 500 feet, and observations of temperature only were made.

R. DEC. WARD.

HARVARD UNIVERSITY.

SCIENTIFIC NOTES AND NEWS.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE spring meeting of the Council of the American Association for the Advancement of Science was held April 18, in Washington, D. C.

The Permanent Secretary, Dr. L. O. Howard, presented for the information of the Council an account of the operations of his office since the last Council meeting. He also presented his financial statement for the last half of the year 1898, which was approved and ordered to be printed. He announced that a contract had been signed which provided for the printing of the Volume of the Proceedings of the Association for 1899 by the Chemical Publishing Company of Easton, Pa.

A number of matters relating to the Columbus meeting the coming August were discussed. The Council expressed its preference in favor of Saturday, August 26th, as the day upon which the all-day excursion should be given, and further, in order that the scientific sessions should not be interrupted, passed a resolution expressing its desire that afternoon excursions and other social functions should not be arranged by the Local Committee to begin before 4 o'clock in the afternoon. It was decided to hold the final public meeting of the Association on Friday night and the meeting of the Nominating Committee on Thursday night. Inasmuch as some dissatisfaction had been expressed with the plan adopted at the Boston meeting of doing away with the general morning sessions, it was decided to resume these daily sessions at 10 o'clock each morning, confining the business, however, to a consideration of matters emanating from the Council and limiting their duration to half an hour.

The Permanent Secretary was authorized to invite Mr. Elihu Thomson to deliver the public lecture at the Columbus meeting.

The Chairman of the Committee on Association Badge reported progress and submitted designs.

An application from Professor C. B. Davenport, of the Museum of Comparative Zoology, Cambridge, Mass., for an appropriation from the Research Fund of \$50 to enable Mr. Charles C. Adams to visit the headwaters of the Ten-

nessee River to collect shells for the genus *Lo* for the purpose of a specific study of variation was referred to the Committee on Grants, with power to act.

GEOLOGICAL SURVEY WORK IN ALASKA.

THE Secretary of the Interior has approved plans submitted by Director Walcott, of the Geological Survey, for the continuation of surveys in Alaska during the summer of 1899. It is proposed that one party, to consist of Mr. W. J. Peters, topographer in charge, and Mr. Alfred H. Brooks, assistant geologist, and equipped with pack animals and outfit, shall proceed from Chilkat Inlet, along the northern side of St. Elias Range, to the head of White River, and conduct such explorations as may be feasible to locate the sources of the Copper, Tanana and Nabesna Rivers. Between the Tanana and the Yukon there is a range of mountains composed largely of the gold-bearing schists. Although quite extensively prospected, but little is known of this range. The explorations will be by the most feasible route to Eagle City and thence westward within the area between the Tanana and the Yukon. It is expected that the party will reach a point on the Yukon in September, and return by the way of St. Michael or, if more advantageous, by way of Dawson.

The second party, consisting of Mr. F. C. Schrader, assistant geologist, and a topographer, will proceed down the Yukon to Fort Yukon, and from there carry forward explorations northward toward the Koyukuk. The object of this party is to explore the principal waters of the Koyukuk within the Arctic Circle. As the region is almost unknown, the special route to be traversed will be left to the discretion of the head of the party. The equipment of the party is to consist of canoes of the same type as those used in the explorations during the field season of 1898. It is expected that the party will return down the Koyukuk to the Yukon and out by the way of St. Michael.

The plans have been developed as a result of thorough discussion by the members of the Survey familiar with explorations in Alaska and the resources of the Territory.

W. F. M.

SCIENTIFIC POSITIONS UNDER THE GOVERNMENT.

A CIVIL service examination will be held on May 9th to establish an eligible register for the position of Expert in Terrestrial Magnetism, U. S. Coast and Geodetic Survey, Department of the Treasury, at a salary of \$2,500. The examination will consist of the subjects mentioned below, which will be weighted as follows: (1) experience in conducting magnetic surveys, including a knowledge of the literature, past and present, of the subject, 30; (2) original investigations and training connected with the study of magnetism, 40; (3) practical questions relative to terrestrial magnetism, 30.

An examination will be held in June for the position of Inspector of Standards, Office Standard Weights and Measures, U. S. Coast and Geodetic Survey, Department of the Treasury, at a salary of \$3,000 per annum. Competitors will not be required to be present at an examination, but a decision will be made on the result of the following tests: (1) training and experience, comprising, especially, original investigations in physics, 30; (2) published papers having special reference to investigations in physics or pertaining to standards of weight and measure, 30; (3) thesis of not less than two thousand (2,000) nor more than four thousand (4,000) words, on the proper functions of a national office of weights and measures, 40.

On May 16th an examination will be held for the position of Field Assistant, Division of Forestry, Department of Agriculture, with a salary of \$1,000 a year. The subjects and weights are as follows: (1) Forestry, 60; (2) Botany, 10; (3) English (essay), 10; (4) Education and Experience, 20.

In view of the scarcity of applicants the examination scheduled to be held on April 11-12, 1899, for Examiner of Surveys, General Land Office, Department of the Interior, has been postponed to May 9-10, 1899. The examination is chiefly on land surveying and the salary is \$5 per day.

GENERAL.

THE National Academy of Sciences at its meeting last week elected the following new members: Charles E. Beecher, professor of historical geology at Yale University; George

C. Comstock, professor of astronomy in the University of Wisconsin; Theodore W. Richards, professor of chemistry in Harvard University; Edgar F. Smith, professor of chemistry in the University of Pennsylvania, and E. B. Wilson, professor of zoology in Columbia University.

DR. DAVID GILL, of the Royal Observatory, Cape of Good Hope, has been awarded the Watson medal of the National Academy of Sciences.

MR. I. H. BURKILL has been appointed assistant to the Director of Kew Gardens.

DR. CHARLOTTE ANGUS SCOTT, professor of mathematics at Bryn Mawr College, has been elected an honorary member of the Amsterdam Mathematical Society.

MR. G. L. TELLER, whose recent work on the Chemistry of Wheat at the Arkansas Agricultural Experiment Station has attracted attention, has resigned his position as chemist of that Station for the purpose of taking charge of chemical work in the Chidlow Institute of Milling and Baking Technology, Chicago. This Institute, recently founded by Mr. David Chidlow, who has been for some time past chemist to the Pillsbury-Washburn Flour Mills Co., of Minneapolis, is the only institution in America which offers the advantages of technical instruction to millers and bakers.

DR. HEINRICH KIEPERT, since 1859 professor of geography in the University of Berlin, well known for his explorations in Asia Minor and important publications, died on April 21st in his 80th year.

CHARLES H. SWAN, a well-known civil and sanitary engineer, died in Roxbury, Mass., on April 17th.

MR. SPENCER H. DEVARRE, formerly instructor in mathematics in Yale University, has died at Brooklyn.

WE learn from *Nature* that the Easter dredging expedition of the Liverpool Marine Biology Committee was brought to an untimely end by an unfortunate boat accident in Port Erin Bay. On March 31st dredging and trawling were carried on from the fisheries steamer *John Fell*, and on the following forenoon the Tanner closing net and the method of pumping plankton

from the bottom by means of a hose-pipe were tried on the steamer. On the afternoon of Saturday, April 1st, two of the workers in the Biological Station went out to collect surface plankton in a small boat. While hauling in the tow-net when returning, the boat capsized, and both were thrown into the water. One of them (Mr. E. J. W. Harvey, of Liverpool) was picked up by another boat from the Biological Station, but his companion (Mr. Eric T. Townsend, of Manchester) was unfortunately drowned before assistance could reach him. The body was eventually recovered. Mr. Townsend was a student at the Owens College, and was occupying the College work-table at the Port Erin Biological Station.

DR. L. BUSCALIONI is making collections in Brazil for the Botanical Museum at Rome.

THE French government is sending an expedition to the Congo to make a topographical survey of the colony.

M. ADRIEN DE GERLACH, the chief of the Belgian Antarctic expedition, will return with the *Belgica* without further explorations after repairs have been made at Buenos Ayres. M. Artowski, the naturalist of the expedition is already on his way home. Lieutenant Danco, who had charge of the magnetic observations, died in June, 1898.

A RUSSO-SWEDISH scientific expedition will start for the Spitzbergen Archipelago in May. The Russians will be represented by Staff Captain Sergiebsky, the zoologist Vinitsky, Dr. Bunge and the geologist and mining engineer Chernysheff. They will go in the Libau ice-breaker No. 2, and the *Bakan*, and join the Swedish party at Stockholm. The expedition intends to winter in Spitzbergen, the Russians at Edge Island and the Swedes at Parry Island.

As we have already stated, the next annual meeting of the British Association will be held at Dover under the presidency of Professor Michael Foster, commencing on Wednesday, September 13th. For the benefit of Americans who may propose attending the meeting, it may be added that notice of papers proposed to be read should be sent before July 1st to the Assistant General Secretary, Mr. G.

Griffith, at the office of the Association, Burlington House, London.

AN electrical exposition will be held in Madison Square Garden, New York, during the month of May.

THE King of the Belgians, as Sovereign of the Congo Free State, has contributed £200 toward the establishment of the London School of Tropical Medicine, and the Secretary of State for India has subscribed £1,000. The Archbishop of Canterbury has also contributed £50 to the same object. Lord Lister, President of the Royal Society, was the principal guest on the occasion of the inaugural dinner in connection with the Liverpool School for the Study of Tropical Diseases on the 22d inst. A sum of £1,700 has been promised towards the expenses of the Liverpool School.

THE Kansas State Legislature has appropriated \$25,000 for a dairy building at the Agricultural Experiment Station and \$6,000 for its equipment. The Oklahoma Legislature has appropriated \$30,000 for buildings and equipment for its Agricultural Station.

It is said that the estate left by the late Baroness de Hirsch has been valued at \$125,000,000, of which \$100,000,000 will be expended in carrying out the various charities founded or fostered by the Baron and Baroness. The Hirsch Foundation in New York City receives \$1,200,000.

MR. ANDREW CARNEGIE has increased his donation for the Washington Free Library from \$250,000 to \$300,000, in order that the building may be of more artistic construction.

WE learn from *The Auk* that the Philadelphia Academy of Natural Sciences has acquired the collection of bird skins made by Mr. Joseph Hoopes, of West Chester, Pa. It contains more than 7,000 specimens, nearly all being North American land birds.

THE following are the lecture arrangements after Easter at the Royal Institution: Professor J. Cossar Ewart, three lectures on zebras and zebra hybrids; Professor Silvanus P. Thompson, two lectures on electric eddy-currents (the Tyndall Lectures); Professor W. J. Sollas, three lectures on geology; Professor

Dewar, three lectures on the atmosphere; Mr. Lewis F. Day, three lectures on embroidery; Professor L. C. Miall, two lectures on water weeds; Mr. Louis Dyer, three lectures on Machiavelli; Mr. W. L. Brown, two lectures on 'To Iceland in Search of Health'; Mr. Edgar F. Jacques, three lectures on 'The Music of India and the East, and its Influence on the Music of Europe' (with musical illustrations). The Friday evening meetings will be resumed on April 14th, when a discourse will be delivered by Professor A. W. Rücker on 'Earth Currents and Electric Traction.' Succeeding discourses will probably be given by Dr. F. W. Mott, Professor C. A. Carus Wilson, Dr. W. J. Russell, Professor T. Preston, the Bishop of Bristol, Sir William Martin Conway, Mr. H. G. Wells and others.

THE Belgian Royal Academy, according to *Nature*, proposes the following subjects for essays in competition for gold medals of value 600 francs each, to be awarded in 1900. The essays are to be sent to the Secretary before August 1, 1900, each bearing a motto, and written in French or Flemish. Contrary to the usual custom, five subjects instead of three have been selected in each of the two departments of mathematical and physical science and of natural science. The mathematical and physical questions refer to: (1) critical phenomena in physics; (2) viscosity of liquids; (3) the carbon derivatives of an element whose combinations are little known; (4) the history and theory of variation of latitude; (5) the algebra and geometry of n -linear forms where $n > 3$. The questions in natural science refer to: (1) the geological formations at Comblain au Pont, and whether these are Devonian or Carboniferous; (2) the physical modifications produced in minerals by pressure; (3) the organization and development of the platoda; (4) the presence of a nucleus in the Schizophyta; (5) the Devonian flora of Belgium.

UNIVERSITY AND EDUCATIONAL NEWS.

ASSISTANTS IN PHYSIOLOGY IN HARVARD MEDICAL SCHOOL.

Two of the four positions offered by the Harvard Medical School to properly qualified men desirous of training in physiological research

and in the management of large laboratory classes in experimental physiology are not yet filled for the next collegiate year. Holders of these positions give more than half the day to research. The remaining time is spent during the first four months in learning laboratory methods and during the last four months in directing the laboratory work of the medical students, two hundred of whom work from two to three hours daily for sixteen weeks in experimental physiology. The fundamental experiments in physiology done by two hundred men working at one time present every variety of results and impart a training in observation and administration not to be acquired in other ways.

Much too may be learned by association; from six to ten men are constantly engaged in research in the laboratory of physiology, and in the departments of anatomy, histology, pathology, physiology and physiological chemistry, all of which have their laboratories in the medical school building, are more than thirty instructors. No charge of any kind is made, either for the training in physiological research and in teaching or for the use of animals and other material. Four of the eight investigations already made by holders of these positions have appeared in the *American Journal of Physiology*, and the others will be published shortly.

In addition to these opportunities the school gives each assistant four hundred dollars for superintending the class work in experimental physiology three hours daily during sixteen weeks.

Applications for these positions should be made to Dr. H. P. Bowditch, Harvard Medical School, 688 Boylston Street, Boston, Mass.

GENERAL.

THE following gifts and bequests to educational institutions have been made since our last issue: \$50,000 to Oberlin College for a chemical laboratory; \$8,000 to Vassar College by the will of Mrs. Luther Elthing for the founding of a scholarship; \$6,000 from Miss Emily H. Bourne for the establishment of scholarships in Barnard College; \$10,000 to the Catholic University of Washington by the will of Miss Mary Moran, and a conditional gift of

\$30,000 to Yankton College, S. D., from D. K. Pearson.

FOREIGN journals report that the late W. J. Astrakoff has bequeathed to the University of Moscow a sum of a million roubles, on condition that it shall be expended upon the foundation of a 'Moscow University for Women,' with three faculties—mathematics, medicine and natural science. He requires that it shall be placed under the direct administration of the Ministry of Public Education and the program correspond exactly with that of the University for men.

THE Mechanical Hall of the University of West Virginia was destroyed by fire on March 4th. The building was insured for \$28,000, and the loss beyond this sum is not great. The building will be immediately replaced.

THE present state of affairs in the Russian universities is extremely serious. Not only has the University at St. Petersburg been closed for some time, but similar conditions exist at Moscow, Kieff, Kharkoff, Odessa, Kasan, Tomsk and Warsaw, and in most of the technical institutes. More than 30,000 young men who will soon form an important part of the intellectual class in Russia are affected. The troubles began by a demonstration against the Rector of the University of St. Petersburg, which was followed by an encounter with the police in which Cossack whips were used upon the students. The Russian government appears to sympathize to a certain extent with the students, and an investigation has been ordered.

THE statement in the daily press to the effect that Dr. J. L. Wortmann has been elected by the Yale corporation professor of paleontology and Curator of the Peabody Museum is incorrect. It is, however, probable that the work in paleontology will be in some way divided between Professor C. E. Beecher, of Yale University, and Dr. J. L. Wortmann.

MR. J. ARTHUR THOMPSON has been appointed professor of natural history in the University of Aberdeen in succession to the late Professor Nicholson.

DR. ROBERT MUIR has been elected to the vacant professorship of pathology in the University of Glasgow. Dr. Muir was last year

called from a lectureship at Edinburgh to the professorship of pathology at St. Andrews. He has published important contributions especially on the pathology of the blood and of the bone-marrow.

MR. W. A. MURRILL has been appointed Assistant Cryptogamic Botanist of the Cornell University Experiment Station for one year, during the absence, in Europe, of Dr. B. M. Duggar. Mr. Murrill is a graduate of the Washington and Lee University, and of the Virginia Agricultural College. He entered upon graduate study at Cornell University two years ago, when he was appointed scholar in botany. During the last year he held one of the positions of graduate assistant in botany at Cornell. He is still continuing graduate work.

EDGAR BUCKINGHAM, associate in physics and physical chemistry in Bryn Mawr College, has resigned his position.

J. H. MCCracken, assistant professor of philosophy in New York University, has been elected President of Westminster College.

TWENTY-SIX fellowships have been announced in the University of Pennsylvania, of which the following were given in the sciences: Reappointments—*Philosophy*, H. B. Alexander; *Mathematics*, R. H. Vivian. New appointments—*Mathematics* and *Astronomy*, U. S. Hanna; *Physics*, H. S. Conrad; *Chemistry*, T. M. Taylor, M. B. MacDonald; *Zoology*, J. R. Murlin, C. B. Thompson; *Pedagogy*, I. B. McNeal.

DR. DANIEL E. ROSA, of Turin, has been appointed associate professor of comparative anatomy in the University at Sassari; Professor Bergen, of Munich, has been made professor of geology and mineralogy in the School of Mining at Clausthal. Dr. Solomon, docent in mineralogy at the University of Heidelberg, has been promoted to an assistant professorship. Dr. W. Wien, associate professor of physics at the Institute of Technology at Aix, has been called to a full professorship at the University at Giessen. Dr. Eggeling has qualified as docent in comparative anatomy and embryology in the University at Strassburg, and Dr. Zermelo as docent in mathematics and theoretical physics in the University at Giessen.

SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; J. LE CONTE, Geology; W. M. DAVIS, Physiography; HENRY F. OSBORN, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; J. MCKEEN CATTELL, Psychology; DANIEL G. BRINTON, J. W. POWELL, Anthropology.

FRIDAY, MAY 5, 1899.

CONTENTS:

'Observations of the Planet Mars.' PROFESSOR G. SCHIAPARELLI.....	633
Dr. Alexander Graham Bell on the Development by Selection of Supernumerary Mammaræ in Sheep. (With Plate V.).....	637
Latest Volcanic Eruptions of the Pacific Coast: J. S. DILLER.....	639
The Prospective Place of the Solar Azimuth Tables in the Problem of Accelerating Ocean Transit: G. W. LITTLEHALES.....	640
Some New American Fossil Fishes: C. R. EASTMAN.....	642
Rapidity of Sand-Plain Growth: M. L. FULLER.....	643
Proposed Survey of the Nile.....	644
Scientific Books:—	
Evans on Birds: DR. J. A. ALLEN. <i>Development's Experimental Morphology</i> : PROFESSOR T. H. MORGAN. <i>Verworm's General Physiology</i> : PROFESSOR D. T. MACDOUGAL. General.....	647
Scientific Journals and Articles.....	651
Societies and Academies:—	
The Philosophical Society of Washington: E. D. PRESTON. The Entomological Society of Washington: DR. L. O. HOWARD. The New York Academy of Sciences; Section of Astronomy and Physics: DR. WM. S. DAY. The New York Section of the American Chemical Society: DR. DURAND WOODMAN.....	652
Discussion and Correspondence:—	
Messrs. Lehmann and Hansen on Telepathy: PROFESSOR WILLIAM JAMES. Two Corrections: PROFESSOR BURT G. WILDER.....	654
Notes on Physics:—	
A New Theory of the Zeeman Effect; Daylight-Phosphorescence: A. ST. C. D.....	655
Notes on Inorganic Chemistry: J. L. H.....	656
Current Notes on Meteorology:	
Blue Hill Observatory Bulletins; Snow Rollers; A Course in Meteorology at Ohio State University; Climate of the Congo Free State: R. DEC. WARD.....	657
A New Marine Biological Laboratory: DR. HUGH M. SMITH.....	658
Theory of the Steam Engine: PROFESSOR R. H. THURSTON.....	659
The Philadelphia Exposition of 1900.....	659
Scientific Notes and News.....	660
University and Educational News.....	664

'OBSERVATIONS OF THE PLANET MARS.'*

THIS is the first volume of a series which promises to be important for the physical study of the planets. It contains a detailed account of the observations made on the planet Mars during an interval of ten months (June, 1894—March, 1895) by Mr. Percival Lowell and his two collaborators, W. H. Pickering and A. E. Douglass. The observatory, especially constructed near the small town of Flagstaff, occupies a central position in the great plateau of Arizona, at an elevation of 7,250 feet above the level of the sea, in latitude $35^{\circ} 11'$ and longitude $111^{\circ} 40'$ west of Greenwich. The choice of that location has been justified by the success attained. During the six months from June to November, 1894, the planet could be observed on nearly every day. On two days out of three it was possible to record useful observations of difficult objects. The atmospheric conditions prevailing during that period (and often during the following winter as well) are sufficiently characterized by the discovery of a great number of details unknown to previous observers. These observations suffice to give an idea of the optical perfection of the instrument employed, which had an objective by Brashear,

* *Annals of the Lowell Observatory*. Vol. I.—Observations of the Planet Mars during the opposition of 1894-95, made at Flagstaff, Arizona. Percival Lowell, Director of the Observatory. Boston and New York, Houghton, Mifflin & Co. 1898. Pp. xii + 392. Large quarto. Plates, xxi.

of 18 inches aperture and $315\frac{1}{2}$ inches focal length. The magnifying powers used were commonly 440 and 617; an eye-piece of power 820 served for the micrometric measurements. Among the auxiliary instruments we mention an Arago polariscope, which has been employed, perhaps for the first time, upon Mars by W. H. Pickering at Flagstaff; also a scale of very fine lines of different sizes, which served for the comparison and estimation of the size and intensity of the lines observed on the planet.

The very numerous and varied observations which form the contents of the present volume have led to many results, the most important of which have been announced by Mr. Lowell in his book 'Mars,' published in 1895. That book contains many discussions and theories of great interest as to the physical constitution of the planet and its atmosphere, its habitability, and as to the most plausible manner of explaining the curious phenomena which have been observed. The substance of those researches and of those discussions has been reproduced in the present volume. The readers of *SCIENCE* have been made familiar with them by the critical analysis of them given by Professor W. W. Campbell in the number for August 21, 1896. I have, therefore, not occupied myself with the theoretical and hypothetical portions, and I am able to confine myself to the observations. In view of their great variety, I shall be obliged to limit myself to the consideration of some of the more characteristic points.

First, as to the polar spots and their periodic variations, which are known to be analogous to those of our polar snows. The manner of development of the polar caps and the phases of their increase are entirely unknown, and it is probable that they will always remain so; for during the period of their increase they are for the most part or wholly enveloped in the night

of the pole. But the process of solution can be followed without much difficulty when the inclination of the equator with respect to our line of vision approaches the maximum value which occurred in 1894. As for the observations at Flagstaff have been made to study the phenomena of the south polar spot from the beginning of June, when its diameter was about 55° , up to its (nearly total) destruction, which occurred toward the end of October.

They were able to follow the changes of its size and shape, its division into parts by the large black band, and to establish further the persistence of certain features isolated from the greater body. They also observed the changes of color which take place in the surrounding dark regions. Plate II., page 46, gives the details of that investigation, which, in comparison with similar work hitherto published, sufficiently shows the superiority of the methods with which Mars has been visually examined at Flagstaff.

I may be permitted to express the conviction that it is by the ever persevering study of the polar spots of Mars that we shall some day arrive at a sound knowledge of the physical nature of that planet, and the interpretation of its singular phenomena. I shall even venture to say that if the southern cap is very inactive in that respect, the northern cap is more so. In fact, the latter develops to a large extent over the regions of a reddish color which it is customary to call the 'dark' regions. The obscure band which reaches its edge has a direct relation to the existence of canals and lakes surrounding it. The same measure as the white spot diminishes under the influence of the solar rays, the darkening takes place in the neighboring regions. In considerable changes, the connection between the white spot and the darkening which with the successive phases of its development is evident. The facts that I was a

establish during the oppositions of 1886 and 1888 make me very strongly wish that the northern cap could be studied by the observers at Flagstaff with the same success as the southern.

A considerable portion of the work is devoted to the phenomenon which is called, according to usage, the *canals* of Mars, the nature of which is still entirely obscure, despite the theories, oftentimes pretty and very ingenious, which they have occasioned.

Mr. Lowell has given a description of these singular formations which seems to me to conform to the truth in the great majority of cases. He has succeeded in showing their character quite well in his drawings. See plates I, IV, V, VI. If there is any defect here, it is that the differences of the size and intensity of the different canals are not indicated with sufficient clearness. I have had occasion to gain some experience in that line of work, and I have no hesitation in saying that this part of the observations at Flagstaff seems to me to be worthy of the greatest consideration. Between the south pole and the thirtieth parallel of north latitude (three-quarters of the whole surface of the planet) previous observers have more or less clearly recognized the existence of 70 or 80 canals. At the Lowell Observatory that number has at one stroke been increased to nearly 200, without counting those whose existence could not be satisfactorily verified. The record of observations of these objects made from June 6, 1894, to April 3, 1895, occupies no less than 85 pages. Frequently 20 or 30 canals could be seen together. In less than an hour, on the night of October 6th, 42 were made out on a portion of the planet which did not amount to a quarter of the whole surface. All three observers took part in the work. The newly discovered canals naturally belong to the most difficult class, and a certain number of them have since been verified by two European observers, Leo Brenner at

Lussinpiccolo and Cerulli at Teramo. I greatly regret that I am unable to add my own name to those, but my eye no longer has the power necessary for successfully carrying out such difficult observations.

Several canals were observed in a state of gemination, among others Ganges, Nectar, Euphrates and Phison. On the 8th of October Mr. Douglass made the very curious and remarkable observation of the gemination of the *Lacus Solis*, which seemed to be divided in two by a luminous band on the extension of Nectar. I made a similar observation in 1890, but then the luminous band was on the prolongation of Eosphoros. The same thing is being observed by M. Cerulli at Teramo during the current opposition of 1899.

As a result of these numerous discoveries and other subsequent ones, as well as future ones, areography is coming to find itself in a condition which may be called an embarrassment of riches. The network of canals has become so complex that there begins to be considerable difficulty in orienting oneself. Imagine three or four hundred of these lines traced all together over a globe of but a few seconds of apparent diameter! The identity of lines seen by different observers at almost the same place is very often doubtful. The difficulty of seeing well and of precisely locating the coordinates of the two extremities may easily give rise to ambiguity and errors. Add to this the frequent changes which the lines undergo in their aspect and their degree of visibility; being now fine and sharp, and again large and diffuse; sometimes double, often entirely invisible—and one is no longer astonished to see the same line, observed by two different men in a slightly different manner, regarded by them as two distinct objects; or, on the other hand, to see two essentially different objects confounded as a single one. The better remedy for avoiding these inconveniences

would be to give up the doubtful objects, and to make as complete and exact a study as possible upon those canals best known and most easily observed, following without interruption the variations of their aspect and of their course, and basing deductions upon precise measures. Precise measures! the thing most necessary and at the same time the most difficult, which ought to receive more attention from skilled observers.

The proportion of new discoveries at Flagstaff on the small dark spots called lakes (Mr. Lowell's *oases*) is relatively still more considerable. Prior to the opposition of 1894 ten to twelve of these formations were known. Mr. Lowell gives a catalogue of more than forty of them. He has shown that in most cases these oases are arranged in regular series on the routes of the longer canals. It is quite probable that minute dark spots, more or less readily visible, must exist at all points of intersection of any two canals.

There is still another class of objects on which the Flagstaff observers have instituted the first thorough research. These are the black lines which furrow the darker portions of the surface of Mars and are ordinarily called the seas. Some lines of that sort had been noticed before, and even a form of gemination had been established for two of them.* In general, previous observers had believed that they saw here lines of the greatest faintness rather than true canals; in only a very few special cases did they succeed in tracing the two edges distinctly. At Flagstaff these lines have been observed and reproduced with much care by Mr. Douglass, who seems to

have a very sensitive and well-trained eye for that sort of objects. From many position angles he traced on two maps the course in the dark regions of the planet of their connection with the canals of the low region. See plates XII and XIII.

The third chapter of the volume contains the work of Mr. Douglass, and deals with a new class of observations which are almost entirely unknown, except for some essays in this direction at Nice and at the Lick Observatory in 1890 and 1892. I refer to the peculiarities which have been very often noticed at the terminator, *i. e.*, on the line where day and night any instant separates the obscure from the illuminated hemisphere. These are most evident when the phase is crescent, and near the quadratures. In by far the majority of cases these irregularities are merely optical illusions caused by the different proportion of the oblique solar illumination returned to us in the different regions traversed by the terminator. There seem to be certain of these irregularities which can only be explained by the presence of elevations or depressions on the surface of Mars. Still others seem to depend upon the presence of very high mountains. These investigations are of much interest not only from their possible bearing upon the topography and orography of Mars, but also from the point of view of the physical history of the planet and its atmosphere.

The work is enriched by a large number of drawings of Mars, some of which are really excellent even from an artistic point of view. See especially plates I and II. We have seen nothing as beautiful as the drawings made by Mr. Green during his expedition to Madeira in 1877. We recognize here not only the geometric figures and the varieties of light and shade, but we can also get some idea of the magnificent coloration observed on the planet.

The chart placed at the end of the

* See on my map of 1892 the two parallel lines which include between them the large island called *Noachis*; one of these is named *Prasodes* on Cerulli's map. See also the two lines which flank the right side of *Syrtis Magna* on my drawing of June 20, 1890, published by Flammarion (*La Planète Mars*, p. 476).



FIG. 1. Normal milk-bag of ewe showing two nipples.



FIG. 4. Ewe born 1892, nipples increased by selective breeding.



FIG. 2. One rudimentary extra nipple.—A Sport.



FIG. 5. Ewe born 1893, nipples increased by selective breeding.



FIG. 3. Two rudimentary extra nipples.—A Sport.



FIG. 6. Ewe born 1895, nipples of equal size increased by selective breeding.

ume is a simple schematic representation, I venture even to say a little too schematic. Each object is designated by a number, and the corresponding name is to be sought in the special tables of regions, canals and oases. This makes the use of the chart troublesome and comparison with other charts inconvenient. All the large and small canals, of whatever degree of importance and visibility, are treated in a uniform manner and are represented by lines of equal intensity; and the same with the oases, with the exception of the largest one of all, called the Lake of the Sun. It is not easy to recognize promptly on the chart many of the objects which are ordinarily seen at the first glance and which are familiar to areographers. Such objects as Indus, Oxus, Ganges, Cyclops, Trivium and Elisium must be sought in an inextricable maze of lines. We have here not a simple index, but one which in use requires itself an index.

I will close this incomplete description of the work on Mars at Flagstaff with the expression of a hope and a wish, namely, that so important a publication should not be limited to a single opposition. The exact and complete knowledge of Martian phenomena demands that the planet should be examined under all possible inclinations of its axis and during all seasons of its year. This requires observations continued at least through *seven* consecutive oppositions. I say, 'at least,' for if the terrestrial seasons are far from following the annual period with mathematical precision, the phenomena of Mars seem still more divergent; and the existence of other periods, longer and more complex, ought to be included among the possibilities. Nevertheless, I think that if we could have before us seven volumes similar to the one under review, and corresponding to a complete cycle of seven oppositions, many facts would be revealed of which we are at pres-

ent ignorant, and many others of which we have at present only dubious indications; especially would this be the case if the seven volumes were the work of the same observers. I therefore hope and wish, as do many others, that Mr. Percival Lowell may be in a position to continue the work so happily begun; that he will soon publish the results of the observations during the opposition of 1896-97, and that the same means which he has employed for the study of the southern hemisphere of Mars may be applied to the still more important observation of the phenomena of the northern hemisphere.*

G. SCHIAPARELLI.

MILAN, March 1, 1899.

ON THE DEVELOPMENT BY SELECTION OF
SUPERNUMERARY MAMMÆ IN SHEEP.†

IN the year 1890 Dr. Bell found that 50 % of the lambs born upon his farm in Nova Scotia were twins, and he made an examination of the mothers in order to ascertain whether the twin-bearing ewes differed in any noticeable degree from those which produced single lambs.

Thirty-three per cent. of the twin-bearing ewes were found to possess supernumerary mammæ in a more or less rudimentary condition, whereas among the ewes having single lambs only 22 % possessed the peculiarity; 43 % of the ewes having supernumerary mammæ bore twin lambs, whereas only 30 % of the normally-nippled ewes had twins.

Although the absolute numbers were far too small to yield reliable percentages, they afforded some ground for the idea that the extra-nippled ewes were more fertile than the others; and Dr. Bell thought it would be interesting to ascertain (1) whether by

* Translated from the author's MS. in French by E. B. F.

† Abstract of a paper read before the National Academy of Sciences at Washington, D. C., April 19, 1899, by Alexander Graham Bell.

selective breeding the supernumerary mammaræ could be developed from their rudimentary condition into real functional nipples yielding milk, and (2) whether in this case the fertility of the ewes would be increased.

In the autumn of 1890 his shepherd, Mr. John McKillop, made an examination of the mammaræ of 890 sheep belonging to farmers in the island of Cape Breton, Nova Scotia. In 811 cases, or 91 %, the sheep were normally nipped, having only two nipples each. In 79 cases, or 9 %, supernumerary mammaræ were present in a more or less developed condition. Some of these sheep had three nipples, others four, a few five, and one ewe had six nipples. In 52 cases, or 6 %, the extra nipples were so rudimentary as to resemble pimples upon the milk bag. In 27 cases, or 3 %, the extra-nipples, though much inferior in size to the ordinary-nipples, seemed to be sufficiently developed to be functional; and most of these sheep were purchased by Dr. Bell and added to his flock.

Dr. Bell presented statistics showing the results of ten years selective breeding for supernumerary mammaræ. The following tables show the number and percentage of lambs born each year having 2, 3, 4, 5 or 6 nipples, and the accompanying chart exhibits the percentages in graphical form:

TABLE I.

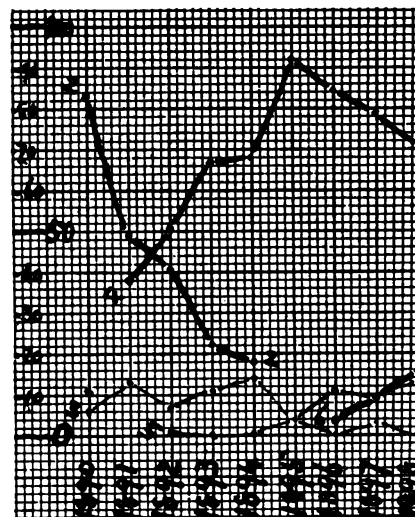
Number of Lambs born each year from 1890 to 1899.

Years of Birth	Total Lambs	Number of Mammaræ				
		2	3	4	5	6
1890	71	59	4	8	—	—
1891	78	38	10	30	—	—
1892	71	29	5	36	1	—
1893	67	15	7	45	—	—
1894	22	4	3	15	—	—
1895	26	—	1	24	1	—
1896	27	—	—	23	3	1
1897	34	—	1	27	3	3
1898	37	—	—	26	5	6
1899	41	—	1	26	6	8

TABLE II.

Percentage of Lambs born each year from 1890.

Year of Birth	Total Lambs	Number of Mammaræ			
		2	3	4	5
1890	100 %	83 %	6 %	11 %	—
1891	100 "	49 "	13 "	38 "	—
1892	100 "	41 "	7 "	51 "	1 "
1893	100 "	22 "	11 "	67 "	—
1894	100 "	18 "	14 "	68 "	—
1895	100 "	—	4 "	92 "	4 "
1896	100 "	—	—	85 "	11 "
1897	100 "	—	3 "	79 "	9 "
1898	100 "	—	—	70 "	14 "
1899	100 "	—	2 "	63 "	15 "



Graphical Chart showing the percentage of lambs born each year from 1890 to 1899 having 2, 3, 4, 5 or 6 nipples (See Table II.).

In the autumn of 1893 the flock was down very severely, and only those were retained which had supernumerary mammaræ in a functional condition. This accounts for the small number of lambs born in 1894. Since that time no lambs have been retained excepting having extra nipples large enough to yield milk.

No normally-nipped lambs (2-nipples) have been born in the flock since 1893. Three-nipped lambs are gradually

pearing. Four-nippled lambs increased from 11% in 1890 to 92% in 1895, since which time the percentage has gradually fallen, the four-nippled lambs being replaced by five and six-nippled lambs. The first six-nippled lamb was born in 1896, and the percentage has increased from 4% in 1896 to 20% in 1899.

Dr. Bell claimed that his statistics showed that he had produced by selection a breed of sheep possessing supernumerary mammae as a normal condition.

Figures are given on Plate V. showing the normal milk-bag of a ewe, extra nipples occurring as sports and the extra nipples obtained by selective breeding.

LATEST VOLCANIC ERUPTIONS OF THE PACIFIC COAST.

THE date of the last volcanic eruption on the Pacific coast of the United States, exclusive of Alaska, has long been a matter of doubt, and will probably remain so for many years to come. Speaking geologically, much of the material in the great volcanic field of the Northwest, including a large part of Oregon and Washington, with portions of California, Idaho and Wyoming, is of comparatively recent eruption. The outbursts may have begun in the Eocene, were most violent and extensive during the Miocene and Pliocene, and, diminishing in vigor, extended, perhaps, up to the borders of the historical period. In Alaska, however, there have been eruptions from Bogoslov, St. Augustin and other volcanoes as late as 1883 and even later, and there can be no question concerning the reliability of the testimony. G. F. Becker gives a list (U. S. G. S., 18th Ann. Rept., Part III., p. 14) of over forty volcanoes in Alaska which have been reported active within historical times.

The evidence, so far as the Pacific States are concerned, is given chiefly by Professor J. D. Whitney (The United States, 1889, p.

114), Major C. E. Dutton (SCIENCE, Vol. VI., p. 46), Professor George Davidson (SCIENCE, Vol. VI., p. 262), and Dr. H. A. Harkness, (Proc. of the Cal. Acad. of Sci., Vol. V., p. 408). Although there are no new facts at hand definitely fixing the date of the last eruption in that region, there has recently come to my attention some information having a bearing upon other evidence.

Last summer Mr. Frederick V. Coville, Botanist of the Department of Agriculture, while studying the flora of Mt. St. Helens, in Washington, found some interesting fragments of charcoal, which he transmitted to the Director of the U. S. Geological Survey, with the following letter:

"I collected two pieces of coniferous charcoal at the point where the trail from Lake Merrill to Mt. St. Helens crosses the Kalama River. Each came from a short charred piece of tree trunk about two feet long and a foot in diameter. My attention was first called to them by Colonel J. J. Hawkins, of Portland. The pieces of charcoal were caught with other fresh drift material brought down the Calama from Mt. St. Helens in last spring's flood. They were charred all the way to the center as evenly and thoroughly as the fragments sent you.

"The character of the charcoal, which need not be described in detail here, is such as at first to suggest that it was made in a very carefully prepared kiln. There are, however, no charcoal pits in the region, and the charcoal from forest fires has a very different character. It is evident from the peculiarities of the flora of Mt. St. Helens, and from its limited erosion, that it is a mountain of very recent volcanic origin. Among other phenomena presented by it was one which, although it did not come under my own observation, is well substantiated by people of the region, and furnishes an explanation of the peculiar sections of charred logs found at the crossing of the Kalama. The phenomena described is the occurrence of molds of tree trunks at various points in the lava flows about the base of Mt. St. Helens. In some places these molds occur in large numbers and lie in the beds in either a horizontal or a vertical position. They are sometimes thirty feet in length, and bear the impress of the bark of the tree in the minutest details. Though I was unable to visit the places where these tree molds occur, I talked with at least half a dozen men who had seen these casts, but none of

them had seen charred wood or bark in the holes. Presumably charcoal was formed only where the lava flow so completely covered the trees as to shut out the air, and the pieces found had been eroded by the Kalama River from wholly submerged molds."

Mr. Coville's conclusion as to the formation of the charcoal is probably correct. Mr. F. H. Knowlton, who studied the structure of the charcoal, recognizes the wood as Douglas spruce (*Pseudotsuga mucronata*). Attention was called (*Nat. Geog. Mag.*, Vol. VIII., p. 226) several years ago to the tree molds or tree wells by Captain P. Elliott. Through Mr. J. H. West, of Woodland, Washington, Mr. F. A. Walpole, one of Mr. Coville's assistants, secured a piece of the basaltic lava from one of these tree molds three feet in diameter. The piece of lava shows the impressions of the bark in great detail. In the hope of obtaining some evidence concerning the age of the lava flow associated with the tree molds and charcoal I entered into correspondence with Mr. West, who reports charred logs at least forty yards up the slope from the high-water mark of Kalama River. One of the charred logs is twenty-eight inches in diameter, and some of them are partly woody, not having been completely converted into charcoal. Near the River at one point the charred logs are found under six feet of sand and gravel, on which are now growing fir trees having a diameter of three feet. Some of the charred logs, therefore, appear to be at least 100 years old, for a fir three feet in diameter would probably require at least that length of time to attain its present size. If this be true it is probable that some of the charred logs are not the result of the last eruption of St. Helens, but of an earlier one. There is historical evidence furnished by Fremont (*Memoirs*, p. 282) to the effect that Mt. St. Helens and also Mt. Baker were in eruption November 23, 1843. At that time a light fall of ashes occurred at the Dalles, Oregon,

on the Columbia, fifty miles from Helens, which was then noted as being in state of eruption. Rev. Mr. Brewer carried some of the ashes and gave them to Fremont, who visited the Dalles a year later. Mt. Baker is thought to have been in eruption at the same time, and the report that the fish in the Skagit River were killed by its ashes. Mr. S. F. Emmerson (*Jour. of the Am. Geog. Soc.*, Vol. IX.) gives the testimony of a former Hudson's Bay trader, who saw an eruption of Mt. St. Helens in the winter of 1841-2.

It is hoped that the question may be settled sometime in the near future by a geological survey of both Mt. St. Helens and Mt. Baker. While it may not be possible to establish the date exactly, the geological records upon the mountain slope are likely to be such as to give the relative age with some certainty. The case of the cinder cones miles northeast of Lassen Peak, California, may be noted as an example of the value of investigation in the field. Professor Harkness was of the opinion that the eruption occurred in January, 1850. The freshness of the material was so striking that Major Dutton and I, who visited them in 1885, were at first of the same opinion. But fuller investigation, an account of which is published in the U. S. Geological Survey Bulletin No. 79, shows conclusively that the explosive eruption from the cinder cones must have occurred long before the beginning of the present century.

J. S. DILLON

U. S. GEOLOGICAL SURVEY,
WASHINGTON, D. C., April 22, 1899.

THE PROSPECTIVE PLACE OF THE SINE
AZIMUTH TABLES IN THE PROBLEM
OF ACCELERATING OCEAN
TRANSIT.

It is not generally recognized that science employing the mathematician and the engineer alike in the problem of shortening the duration of ocean transit, has accomplished

as much by causing ships to go fewer miles as by causing them to go faster.

This generation is familiar with the part that has been played by steam propulsion in increasing the speed of ships, but, besides the increase in the rate of travel, modern motive power, by making possible a departure from the old meteorological routes, has had another and a greater effect in the progress of the universal policy of civilized nations to accelerate transit from place to place to the utmost possible extent. When the wind was the sole motor of ocean-going vessels the best economy was realized by passing through regions of favorable meteorological conditions without reference to the directness of the route. Thus, in sailing from Europe to the United States, it was customary to pass southward along the eastern shores of the Atlantic to the Cape Verde Islands, and thence westward through the trade-wind region along the route followed by Columbus on his first voyage to the New World, and finally northward into the region of prevailing westerly winds and along the western shores of the Atlantic to the point of destination. In making this voyage, ships traversed 4,400 miles in passing between ports that were only 2,400 miles apart on the surface of the earth.

Under steam, even if they go no faster, ships may yet get farther toward the port of destination in a given time because the winds and currents may be disregarded, and they may be navigated over the oceans along great circles of the earth.

The increasing recognition among mariners of the sound principle of conducting a ship along the arc of the great circle joining the points of departure and destination and the expanding sense of the advantages to be gained by a knowledge of this branch of nautical science have greatly heightened the value of methods which place the benefits of the knowledge and use of the great-

circle track at the service of the mariner without the labor of the calculations which are necessary to find the series of courses to be steered. Inasmuch as great-circle courses alter continuously in proceeding along the track, it becomes necessary to know the latitude and longitude of the ship in order to determine the course to be followed. At the present day there are convenient means for determining at sea the longitude as well as the latitude, but before the early part of the present century these means did not exist, and great-circle sailing was impracticable. The general lack of the application of the principles of the great circle in later times, and even in the present generation, seems to have resulted not from the want of recognizing that the shortest distance between any two places on the earth's surface is the distance along the arc of the great circle passing between them, nor that the great-circle course is the only true course and that the courses in Mercator and parallel sailing are circuitous, nor yet to a due appreciation of the advantages to be gained by a knowledge of the great-circle course as a means for obtaining the most advantageous track in windward sailing; but to the tedious operations which have been necessary, and to the want of concise methods for rendering these benefits readily available.

The solution, every time the course must be determined, of a spherical triangle in which the two sides and the included angle are given is a formidable operation for a mariner as compared with the measurement on a compass diagram of the direction of the straight line representing the circuitous path of the ship's track on the Mercator chart. At page 662 of the ninth edition of a work on Practical Navigation by Captain Lecky, of the Royal Naval Reserve of Great Britain, there is a section entitled 'Great Circle Courses found from Burwood's Tables,' which has doubtless been

read with profit by thousands, for it states that "to find the great-circle courses from the azimuth tables you have only to regard the latitude of the port bound to as declination, and the difference of longitude, turned into time, as the hour-angle. The latitude of the ship you take from the top of the page as usual." But the author goes on to remark that, as Burwood's solar azimuth tables extend only to twenty-three degrees of declination, this ready-made method is only applicable when the place of destination is within the tropics.

It may be of value, therefore, to point out that the solar-azimuth tables are universally applicable for finding great-circle courses, because all great circles pass into the tropics, and, if the problem of finding the courses is with reference to a great-circle track between a point of departure and a point of destination, both lying outside of the tropics, it is only necessary to find a point lying on the prolongation of the great-circle arc beyond the point of actual destination and within the tropics, and treat this point as the place of destination in finding the courses.

The longitude of the selected point within the tropics may be found without any calculation by simply prolonging the straight line representing the great circle upon a gnomonic chart. By this combination of the gnomonic chart and the azimuth tables the courses upon a great circle track may be determined with very great facility.

To illustrate, take the problem of finding the initial course on a voyage by the great circle route from Bergen, in latitude 60° N. and longitude 5° E., to the Strait of Belle Isle, in latitude $52^{\circ} 1' 2''$ N. and longitude 55° W. On a copy of a gnomonic chart, such as Godfray's, draw a straight line between the geographical positions above stated and extend it beyond the latter into the tropics. It will be found to intersect the 20th degree parallel of latitude in longi-

tude 90° W., or 95° from the meridian the point of departure. Entering azimuth table at latitude 60° , under declination 20° , and opposite hour-angle 6h. 20m., we find the required course N. $75^{\circ} 31'$ W.

G. W. LITTLEH

SOME NEW AMERICAN FOSSIL FISHES

THE following new occurrences of fishes were reported: (1) A species of *Cladodus*, scarcely distinguishable from *striatus* Ag. in the Corniferous Limestones of Ohio. (2) *Thelodus*-like scales from the horizon. (3) A pair of naturally associated pectoral spines of *Machæracanthus* from Hamilton, near Buffalo, N. Y. (4) A chopterygian pectoral fin from Naples of the same locality. (5) Two new species of *Diplodus* from Upper Devonian near Chicago, Ill. (6) Teeth of *Phæbodus* from Keokuk Limestone of Iowa and of Nebraska. (7) Largest known species of *Stethacanthus* (length over 35 cm.) from Keokuk Group, Iowa. (8) A complete set of fin, spines and shagreen scales of a new and very large species of *Acanthodes* genus not hitherto met with in the United States, from Coal Measures of Mazon, Ill. (9) *Pholidophorus americanus* sp. new, also belonging to a genus new to this country, founded on very perfect material covered by N. H. Darton, of the Geological Survey, in the Jura of the Black Hills, South Dakota.

Photographs of the new Jurassic *Acanthodes* were exhibited and their specific characters summarized as follows: Gracefully elongated form, upwards of 15 cm. long, the head forming about one-fourth the total length and slightly less than maximum depth; trunk; dorsal arising behind pelvic region; scales not serrated, thin, smooth, non-overlapping; flank series

* Abstract of a paper read before the Boston Society of Natural History, March 15, 1899.

especially deepened. This places them among the more primitive members of the genus, and hence would seem to indicate a Lower Jurassic horizon.

The distribution of American Devonian fishes was discussed with reference to those of other countries. During the Lower Devonian there was none, and in the Upper scarcely any intermingling of United States and Canadian vertebrate faunas, but those of Canada and Great Britain belonged to a distinct province. Corniferous fishes of Ohio and New York are most nearly related to those of the Middle Devonian of continental Europe, especially the Eifel, Bohemia, etc. The Hamilton faunas of New York and the Mississippian region, including Manitoba, are the direct successors of the Corniferous, but the Chemung of both eastern and western regions (or its equivalent) contains a remarkable mixture of indigenous types and intruders from all directions. Intercommunication between eastern Canada and Great Britain, Spitzbergen, etc., became general for the first time during this period. The transition between Devonian and Carboniferous faunæ is now known to be more gradual than was formerly supposed.

The only natural basis of family classification among *Arthrodires* was held to be through comparison of the sutures of cranial and dorsal shields, the differences in dentition being of only secondary importance. Degeneracy of the latter in *Titanichthys*, etc., is paralleled by that in certain toothless whales (*Mesoplodon*, etc.). Cranial osteology of *Homosteus* and *Heterosteus* compel their removal from *Coccosteidae* to form a separate family called *Homosteidae*. In this family the so-called antero-dorso-lateral corresponds to the like-named element in *Dinichthys* and *Titanichthys* plus the clavicular. The latter plate functioned as a support for the gills, and hence may be interpreted as a modified branchiostegal apparatus, but in

no sense as a part of the shoulder-girdle. There is no evidence that any of the *Arthrodires* possessed pectoral fins. The obvious resemblance of this group to Ostracoderms, with implied relationship, is lost sight of through its removal by Woodward to the Dipnoi, and there seems to be sufficient evidence for regarding the *Arthrodira* as a distinct sub-class, of equal rank with Lung-fishes, Teleostomi, etc., as already suggested by Dean.

CHARLES R. EASTMAN.

RAPIDITY OF SAND-PLAIN GROWTH.*

THE undisturbed character of the stratified deposits making up the sand-plains, taken in connection with the absence, or at most, the very slight development of constructional back-sets, indicates, as was early pointed out by Davis, a stationary ice margin during the period of deposition. It follows, therefore, that their formation must have been extremely rapid, and the natural conclusion is that they represent the deposits of a single summer's period of melting, an interval not over eight months in length.

It occurred to me that a calculation based upon the conditions now existing in the large glaciers of Alaska might give some indication as to the probability of such estimates, or at least would be of interest in this connection.

To make this calculation it is simply necessary to divide the bulk of the sediments by the daily discharge of detritus by the glacial stream which deposited them. This involves factors which are usually very difficult to determine, but at the sand-plain near the railroad station at Barrington, R. I., the conditions are almost ideally perfect, and admit of the determination with considerable accuracy of both the bulk of

* Abstract of paper read before Boston Society of Natural History, February 15, 1899.

the sediment and the size and velocity of the stream transporting it. Owing to the fact that observations as to the amounts of the fine clay-like detritus of glacial streams are more numerous and reliable than those upon the coarser material, the bulk of the contemporaneous clays was taken as a basis of calculation, rather than the sand-plain itself. In estimating the load of the glacial stream, I have taken the maximum value of 13 grams per liter, given by Reid for the Muir Glacier (the highest value on record), as the one which, in all probability, would most nearly correspond to the load of a glacial stream during the closing stages of the continental ice sheet.

At the time of the formation of the Barrington clays the land stood at a level of at least forty feet below that at present existing, and the deposition took place in an inclosed bay, having the ice sheet as its northern boundary, a ridge of till and modified drift for its eastern boundary, and an earlier sand-plain as its southern boundary. On the west was a broad and deep opening, connecting with Narragansett Bay, and admitting of a complete commingling of the salt and fresh waters. Into this inclosed bay flowed a stream with a width, as indicated by its esker, of 150 feet, a depth of some 20 feet, and an average velocity of not over 5 feet per second. On the assumption that the amount of sediment was 13 grams per liter, the daily discharge of clayey material would have been some 526,500 tons per day.

Experiments recently conducted by Professor W. O. Crosby in connection with professional work for the Metropolitan Water Board of Massachusetts, the results of which he has kindly placed at my disposal, indicate that material such as the clay beds are essentially composed of, *i.e.*, quartz-flour, settles with great rapidity, and it can be shown that practically the entire amount of sediment brought in by

the glacial stream must have been deposited within the inclosed bay described.

The clays cover about a square area, have a maximum thickness of and a total bulk of 95,300,000 tons. Dividing this bulk by the daily discharge of material by the glacial stream (526,500 tons), the time of deposition of the clays is calculated to have been 181 days, or almost exactly six months.

The Barrington deposits probably represent very nearly average conditions; a period of six months seems a fair estimate of time for the formation of a simple plain of moderate size. In the case of plains, with areas of several or many miles, the period of deposition may be considered as extending over more than a season of melting, there being in the time either no retreat of the ice margin or retreat so slight that the intervening space was completely filled and the sand-united into a single compound plain.

MYRON L. FULLER

PROPOSED SURVEY OF THE NILE

THE Egyptian government has agreed to undertake a survey of the Nile with the object of determining the species of animals inhabiting its waters. It is due in part to the instance of the efforts and energetic assistance of Dr. John Anderson, F.R.S., who has already done so much to enlarge our knowledge of the fauna of Egypt that this important project, to which so much scientific interest is attached, has now taken definite shape. A memorandum prepared by him setting forth his proposals for the survey of the lines of his scheme for carrying it out, received the approval of Lord Lister, President of the Royal Society; Professor E. Lankester, Director of the Natural History Departments of the British Museum; Dr. Günther, President of the Linnean Society; and Mr. P. L. Sclater, Secretary of

*From the *London Times*.

Zoological Society, and was then forwarded by him to Lord Cromer, to be submitted to the Egyptian government, with a strong recommendation for its favorable consideration from these eminent scientific men. The Trustees of the British Museum furthermore gave the scheme their powerful and influential support, and intimated their willingness to assist in a practical manner by undertaking to supply the necessary collecting-boxes, with alcohol to fill them. An essential feature of the scheme is that the fishes collected are to be sent to London to be studied and determined by Mr. Boulenger, the ichthyologist on the staff of the Museum, and the Trustees have, it is understood, agreed to give him every facility for doing this, thus practically placing the services of their officer at the disposal of the Egyptian government for the purpose for the three years which it is estimated will be required to accomplish the survey.

Our knowledge of the fishes of the Nile appears to be very imperfect. It may be said to have taken its origin in 1750, when Hasselquist described thirteen species found in the Deltaic area or in its immediate proximity. In 1847 sixty probably represented the number of known species. In 1861-63 Petherick made, at Dr. Günther's request, a collection of fishes from the Nile for the British Museum. The specimens were obtained at Cairo, Khartum and Gondokoro, and were described by Dr. Günther in an appendix to Petherick's 'Travels,' published in 1889. The collection contained eighteen new additions to the fauna, and raised the number of known species to eighty-two. Since 1869 the fishes of the Nile have been almost completely neglected. At present about ninety species are known to inhabit the river, but this number, considering the vast extent of its waterway and the very diverse physical conditions which characterize many parts of its course, cannot be considered as at all approaching finality.

The collections hitherto made from the Nile have principally been obtained from below the First Cataract; indeed, Rüppell and Petherick are the only two collectors who had opportunities to investigate the river above Assuan. The former distinguished traveler and naturalist largely collected in lower Egypt, and not a few of Petherick's specimens were from the same region. In Dr. Günther's account of this collection only six species were distinctly recorded as coming from Gondokoro, Khartum and the White Nile, while thirteen, besides the foregoing six, species were stated to belong properly to the reach of the Nile above the Sixth Cataract. Here it may be observed that, while we possess a fragmentary knowledge of the species from Khartum southwards, the immense tract of the Nile from the First to the Sixth Cataract remains practically untouched.

Moreover, as within the next few years a change will be effected in the distribution of the Nile waters by the construction of the controlling powers now in course of erection at Philæ and Assiut, and as other similar structures or dams are likely to follow towards the south, all of which are certain ultimately to limit more or less the range of certain species of fishes, it is much to be desired that, before any of these triumphs of the Department of Irrigation have been completed, we should be placed in possession of the main features and present condition of the piscine flora of the great reaches of the river.

The present time is also extremely opportune for the commencement of the proposed investigation, since the authorities of the Congo Free State have satisfactorily inaugurated a survey of the Congo. Mr. G. A. Boulenger has been entrusted, with the sanction of the Trustees of the British Museum, with the description of the fishes of the Congo for the Congo Free State, and, as his services will be at the disposal of the

Egyptian government for the Nile exploration, the two surveys should mutually benefit each other. The materials afforded by the one cannot but throw light upon those of the other, many of the species of the two great rivers being closely allied.

As regards the scope and working of the survey, it is suggested, as a preliminary step, that a series of stations should be established along the river, extending, at intervals, from the Delta to Lado, in the territory leased by the Egyptian government to the Congo Free State, and as far to the south of this as possible. Instructions for collecting fishes, written in English and Arabic, will be sent to some responsible official in each of these localities, accompanied by a collecting box and alcohol, supplied by the British Museum, while the services of fishermen and others will be enlisted in the work, a fair price being paid to them for the fishes they collect.

Dr. Keatinge, the officer in charge of the Museum of Natural History of the Medical School of Cairo, has been entrusted with the general supervision of the service of the survey. He will see to the reception of the collecting materials from the British Museum, to their distribution to the different stations, to their reception when returned filled with fishes, and to forwarding them to London. The actual superintendence of the working of the survey is to be undertaken by an officer, who will be constantly on the river at all seasons, visiting the different stations, inspecting the collections formed, making sure that everything possible is being done to obtain fishes, and generally satisfying himself that the specimens are properly preserved, and that they are fairly representative. He will also particularly note the physical characters of the river at each station, find out as much as possible about the habits of the fishes, the depth at which they are found, the general character of the river bed, the seasons in

which the fishes breed, and the nature of their food. He will further be required to satisfy himself that the native names have been correctly recorded in Arabic, and that the names are correctly and rightly applied.

Mr. Leonard Loat has been appointed to this responsible post of superintending the survey, and on him will devolve the task of seeing that the work is carried in a thoroughly efficient manner. He left London a short time ago for Cairo, and has already commenced operations on Menzaleh. During the first year it is proposed to carry the investigation as far as Wady Halfa; in the second year the work will be worked between Wady Halfa and Berber, and in the third year it is hoped to continue the survey to Sobat, and, if conditions are favorable, through the *sud* rapids between Lado and Dufile, and ultimately, perhaps to carry the exploration of the river to its origin in the Albert N'Yai. In this connection it may be stated that the assistance of the authorities of the Congo Free State has been invited, and an assurance of their hearty coöperation has, it is understood, been received informally, leaving no room for doubt that an official expression to the same effect will be shortly forthcoming.

These are the lines on which the projected survey of the Nile is to be conducted. It is obvious that, apart from the mere knowledge of how many species of fishes exist in the river, great economic questions come to the front when their life-history is studied. Also it is hoped that the study may help to elucidate many problems relating to the fishes sculptured on the ancient monuments of Egypt. Dr. Anderson is giving special pains to obtain drawings of many of these fish forms as possible, and it is regarded as not improbable that a scientific investigation of the fishes obtained in the river will lead to an identification of many of the species represented in stone. T

questions, however, can never be usefully determined until there exists on record a basis on which to work, in the form of a detailed description on each species accompanied, as far as practicable, by a figure. The scheme, therefore, includes provision for the publication of the scientific results in a book uniform with the sumptuous volume which Dr. Anderson has recently issued on the 'Reptiles and Batrachians of Egypt.' This work forms the first volume of the 'Zoology of Egypt.' He is at present engaged in working out the collections of mammals on which the second volume will be based. The 'Fishes of the Nile' will form the third volume of this monumental record of the fauna of the country.

SCIENTIFIC BOOKS.

Birds. By A. H. EVANS, M.A., Clare College, Cambridge. London, Macmillan & Co., Limited; New York, The Macmillan Company. 1899. 8vo. 144 text cuts. Pp. xvi + 635. Price, \$3.50.

Mr. Evans's 'Birds' forms Vol. IX. of the 'Cambridge Natural History,' and is intended as a popular systematic review of the class Aves. In a volume of 650 pages it is, of course, impossible to treat in much detail any of the one hundred and thirty odd families of birds, or to particularize respecting many of the 12,000 to 13,000 or more species now recognized by systematists. It would seem, however, that a little more space might have been profitably given to the generalities of the subject, as structure, classification, geographical distribution, migration, etc., all of which is compressed into the short space of twenty-two pages, of which three are devoted to the terminology of the external parts of a bird. The remarks on classification and geographical distribution are mainly historical. Mr. Evans adopts, with 'some slight modifications,' Dr. Gadow's scheme of classification and Sclater's scheme of geographical areas. In referring to the wide differences of opinion among authorities on the subject of genera and species he says: "It cannot be denied that genera and species are merely

'convenient bundles,' and that divisions of either, if carried too far, defeat the object for which classification is intended. Genera are only more distinct from species, and species from races, because the intervening links have disappeared; and if we could have before us the complete series which, according to the doctrine of evolution, has at some time existed neither genus nor species would be capable of definition any more than races in many cases; while the same remark will apply to the larger groups." While such statements are not new they have not been presented in popular works, the lay reader being allowed to retain the old idea of the tangible nature of generic and specific groups. The tendency among certain systematists to recognize subspecies on the basis of the slightest recognizable differences leads naturally to the multiplication of genera, and the increase of subfamilies, etc., to conform, so to speak, to the new unit of measurement consequent upon the recognition, in nomenclature, of the grade of differentiation that is considered as a sufficient basis for 'races' or subspecies. It is to this, doubtless, that Mr. Evans alludes as being likely to 'defeat the object for which classification was intended.'

Beginning with *Archæopteryx*, and ending with the Finches, the various groups of birds are passed briefly in review. The characters of the ordinal, subordinal and family groups are succinctly stated, and some little account is given of the number, distribution and habits of the species, the latter usually in general terms. Very little is said about any particular species, though sometimes a characteristic member of a group is taken as the subject of more definite remark, or in cases where the number of species is so few that something may be said of each. The reader may be thus often disappointed, in seeking information regarding particular species, to find little, if any, reference to the object of his search. In a work of the dimensions of the present volume this must be inevitable, yet it will prove a convenient source of information on the general subject of bird life throughout the world. References to more detailed accounts of species or groups of particular interest are, however, often supplied in foot notes. Only about one-sixth of the work is de-

voted to the *Passeriformes*, which nearly equal in number of species the rest of the class, only a few pages being allotted to even the larger families; and the various generic groups are mentioned, as a rule, only by their technical generic names. The book is thus evidently not really adapted to beginners, nor wholly suited to the general reader, though apparently designed 'not only for the tyro in ornithology, but also for the traveller or resident in foreign parts interested in the subject.' The woodcuts that quite fully illustrate the text are, for the most part, excellent, and prepared especially for the work by G. E. Lodge; others are familiar through frequent previous use. Considering the limitation of space imposed for the subject, the author has, perhaps, supplied all that could be rightfully expected, and has certainly shown himself to be 'up to date' in all of the essentials of his subject.

J. A. A.

Experimental Morphology. By CHARLES B. DAVENPORT. New York and London, The Macmillan Company. 1899. Part Second. Pp. 228.

The second part of Davenport's *Experimental Morphology* that has just appeared deals entirely with phenomena of growth. The first volume described the effects of chemical and physical agents upon protoplasm, and it is intended to devote the third volume to cell-division and the fourth to differentiation. The author states that it is the aim of this series 'so to exhibit our present knowledge in the field of experimental morphology as to indicate the direction for further research.'

The present volume gives a clear, brief statement of what is known in regard to growth in plants and animals. Most of the illustrations are taken from plant physiology, and it may, therefore, be questioned whether a zoologist is in position to summarize so large and important a field of botanical research, but in justification it should be stated that Davenport has attempted to deal with the subject from a common biological standpoint.

In reading this volume one cannot fail to be impressed by the enormous difference in our knowledge of growth-phenomena in plants and

animals. The subjects dealt with cover the most interesting fields of biological the responses of organisms to their surroundings and the relation of these response conditions of life under which the forming or has lived in the past. The introductory chapter is intended to give an idea of growth. Organic growth is defined as increase in volume—'it is not development, not differentiation and not increase in mass.' A brood of this sort, while convenient to a large number of changes resulting in increase in volume, may lead to difficulties. An attempt is made to find a common explanation of all the phenomena included in the definition for the processes that take place in plants and animals that produce an increase in volume. It may be entirely different in their nature. The author has skillfully avoided this pitfall in many cases, although at times one cannot but find that a most heterogeneous collection of phenomena has been included in the same category.

The first chapter (XI.) deals with the effect of chemical agents on growth, and gives in compact form a large amount of useful information. In most cases the action of the substance is purely physiological and only secondarily formative. It is not obvious why so much space should be given to pure plant physiology. It is, no doubt, difficult to draw the line between substances that act as foods and other substances that produce growth, since the latter often (but not always) depend on the former.

An admirable account of the rôle of water in growth is given in Chapter XII. Here the author has some new facts that bear on the problem. In the next chapter, dealing with the effect of density of the medium on growth, results are summed up as showing that diminution or growth is proportional to the osmotic action of the medium. It is possible, however, that the effect is due also, in part, to the direct injurious action of the salts used to increase the density of the fluids. If due to osmotic action alone, then, the results should be low when different substances are used at the same osmotic equivalent, but the few facts that are given do not entirely support this general conclusion.

In Chapter XIV. the effect of molar concentration

dealt with. The effects of rough shaking on bacteria and of tensions and torsions on plant tissues are described. Nothing is said in regard to the changes that take place in bones, as a result of displacement, etc. The closing of wounded surfaces (in *Stentor* and *Hydra*) is said to 'be grossly mechanical.' I may add from observations of my own that, in some cases at least (in *Tubularia* and in the embryo of *Rana*), the closing of the wound after injury cannot be explained as grossly mechanical, but is due rather to a movement of the living cells in response to a stimulus.

The action of parts of plants in response to contact and the general phenomena of bending in seedlings, etc., can scarcely be included in a definition of growth, even as broadly defined by the author, for while there is an increase in volume on one side there may be a corresponding decrease on the opposite side, the volume of the whole plant or part remaining approximately the same.

A brief account of the effect of gravity is given in Chapter XV. Two classes of effects are distinguished, the first mechanical, "due to gravity, acting on the growing organ as it might on any other heavy body. The second is a vital effect, having no immediate, direct physical relation to the cause." It seems a little obscure to state that a vital effect has 'no immediate, direct physical relation to the cause.' That the connection is a causal connection, even if a remote one, few will be bold enough to deny. The distinction that the author wishes to make is, perhaps, fairly clear, but the words may easily lead to a misconception of what is meant by vital effects. Again, on page 417 (in Chapter XVII., dealing with the effect of light upon growth), the author concludes, after showing that the eggs of many (but not all) animals are sheltered from sunlight, 'that, in general, growth does not take place in nature in full sunlight.' It is obvious that in many cases the eggs deposited in the dark are better concealed, and it is not improbable that this may account for their development in the dark. Under these conditions they would become attuned to the absence of light. The more rapid growth of plants in the dark is described in detail, the effect of colored light on the growth of

animals and plants, and the direction of growth in response to light, are discussed at some length.

The effect of heat on growth, as well as on the direction of growth (in plants), is dealt with in Chapter XVIII. The interesting fact is pointed out that under certain conditions the bending of a plant towards the source of heat cannot be explained as the direct result of the heat causing growth on the warmer side, since the concave side is the one turned towards the source of heat. This experiment may well make one question whether or not these phenomena of bending are growth phenomena in the ordinary use of the terms.

In the concluding chapter the cooperation of several factors in normal growth is analyzed. A clear summary of the work of Semper and de Varigny on the growth of water-snails in a confined space is given. There is some excellent matter in the few pages of this chapter, although here and there one may find fault with the expression rather than with the general sense. The attunement or acclimatization of an organism to its surroundings is emphasized. A tentative hypothesis to account for the attunement is offered. This attempt to construct a possible explanation brings clearly to light that the author pictures to himself these 'vital phenomena' as chemical responses to external agents. The contrast, therefore, so often made in the text between physical and vital effects would seem to be a difference between physical and chemical reactions. If anything more than this is intended it is not included in the final attempt at an explanation, although it is stated on a preceding page that the 'specific effects' cannot at present be accounted for by known chemical processes, 'but result from peculiarities of the specific protoplasts which depend largely upon the past history of each kind of protoplasm.'

If we have taken issue with the author on a few points it is only because in these the book appears incomplete or imperfect. Taken as a whole it is a valuable addition to our text-books, and the author is to be congratulated on having performed so difficult and arduous a task with success. The careful and exact summaries that are given will be of use to those not having access to the original papers.

The book contains many tables compiled from various sources. The data are generally given in the form of curves so that a large amount of information may be comprised in a single diagram. The clear and judicial discussion of the topics makes the book a model of its kind. Especially praiseworthy is the absence of the rash speculation so predominant in biological literature of recent years.

T. H. MORGAN.

BRYN MAWR COLLEGE.

General Physiology. By PROFESSOR MAX VERWORN. Translated and edited from the second edition (1897) by PROFESSOR F. S. LEE. New York, Macmillan & Co. 1899. Pp. xvi+616. 285 figures.

The subject-matter of this book is arranged in five chapters with headings as follows: The aims and methods of physiological research, living substance, elementary vital phenomena, the conditions of life, stimuli and their action, and the mechanism of life. The English edition is very happily rendered, and is characterized by an extremely small residuum of Teutonic idioms, while the privileges of the editor have been very skillfully but sparingly exercised.

The book is chiefly concerned with the cell as such and as organism, and it seems to the writer that it hardly justifies the resounding title of 'General Physiology, or the Science of Life.' It is usually unfair to pass judgment upon the nature of a work from any single paragraph which may be required in a review, but the closing sentences of the volume are fairly indicative of the author's conception of his subject. "The cell is the element of living substance. All living substance exists in cells, and all of the functions of living substance originate in the elementary vital phenomena of cells. Hence, if the task of the physiologist lies in the explanation of vital phenomena, general physiology can be only cell-physiology." These sentences are faultlessly rhetorical, but they do not exhibit an unsailable logic, at least from the point of view of the botanist, or the physiologist interested in the general properties of organisms.

The work of investigators upon the physiology and organization of the protoplasm of plants

has been somewhat more uniformly devoted and the results attained have been of wider interpretation than similar effort in the animal world; hence the value of this as a reactionary protest against the minor profitless specializations which have absorbed so much of the energy of the animal physiologist is not so apparent to the plant physiologist. The latter feels no need for a return to investigations in cell-physiology, since his research upon all the more important activities of the protoplasm have been extended to material of the widest range of morphological and physiological differentiation, and have been an investigation of principles rather than a study of the functions of special tissues.

Without reference to the above, the book is a very valuable and welcome addition to the library and laboratory accessories of the physiologist, not for what it contains of plants, for the paragraphs devoted to the animal organisms are teeming with errors and omissions or are badly antiquated, but for its comprehensive treatment of the composition and elementary activities of protoplasm, and the metabolic and directive reactions to stimuli, and the discussions devoted to these subjects are well executed. The historical sketch of the development of the methods of physiological research, as well as the metaphysical discussions of the conditions of life properly belong here, although they do not constitute the most valuable or striking parts of the book.

It appears to the reviewer that the physiological aspects of the form and size of the cell have been but scantily touched upon; that the rôle and distribution of inorganic matter in the cell do not take into account the greater mass of the available information on that subject, while secretion, absorption and election of food do not receive deserved attention. The fatuous distinction between organized and unorganized ferments bids fair to be immortal, since it is continued here and in many other prominent recent works. Recently issued, although yeast, the well-known example of the 'organized ferments,' has been found to secrete definite enzymes, as is the case with all ferment organisms. It is certainly antiquated to quote Sachs to the effect that starch is the first 'visible product' of

activity of the chlorophyllaceous cell in the sunlight. The curvature of twining stems is not thigmotaxis (p. 443). The use of the phrase 'conduction of a stimulus' to indicate the transmission of an impulse from the point of reception of the stimulus to a reaction zone is a mistake resulting from the literal translation of 'Reizleitung.' The German word 'Reiz' having a broad meaning which permits its use to designate both the stimulus and the stimulus-effect. 'Every change in the external conditions of an organism constitutes a stimulus;' but it is to be presumed that no one would mean that these changes in the intensity of external energy, rather than the shock of such change, are transmitted by nerves or other conducting mechanisms.

Perhaps the most remarkable omission in the entire work is that which occurs in the discussion of the history of death. No attention is given to the aging or senescence of cells, and there is no mention of any example of the plant cell in the histolytic processes, or metamorphic death, although this phenomenon is of such importance that all types of plants furnish dead cells from normal atrophies and degenerations, while in the higher types the greater bulk of the plant-body is made up of dead cells.

The greater number of the faults enumerated above would be due to the inaccessibility of the botanical literature to the animal physiologist, and are of such nature that they may be easily eliminated from future editions. The book has a long period of usefulness before it. It is stimulating and suggestive, and will do much to broaden investigation upon both the animal and vegetal organism; a purpose it would accomplish equally well under its proper title of 'The Physiology of the Cell.'

D. T. MACDOUGAL.

UNIVERSITY OF MINNESOTA.

GENERAL.

THE last Legislature of the State of Arkansas provided for the printing of the hitherto unpublished reports of Dr. J. C. Branner, formerly State Geologist of that State. There are five volumes of these reports, viz: (1) Coal; (2) Lower Coal Measures; (3) Clays, Kaolins and Bauxites; (4) Zinc and Lead; (5) Report on

the general geology of the State. Provisions were also made for printing new editions of the reports already out.

THE sixth volume of Biological Lectures from the Wood's Holl Laboratory, in the press of Messrs. Ginn & Co., will contain:

- 'The Structure of Protoplasm,' E. B. Wilson.
- 'Cell-Lineage and Ancestral Reminiscence,' E. B. Wilson.
- 'Adaptation in Cleavage,' Frank R. Lillie.
- 'Protoplasmic Movement as a Factor of Differentiation,' Edwin G. Conklin.
- 'Equal and Unequal Cleavage,' A. L. Treadwell.
- 'Cell Origin of the Prototroch,' A. D. Mead.
- 'Relation of the Axis of the Embryo to the First Cleavage Plane,' Cornelia M. Clapp.
- 'Observations on Various Nucleolar Structures of the Cell,' Thomas H. Montgomery, Jr.
- 'Protoplasmic Contractility and Phosphorescence,' S. Watasé.
- 'Some Problems of Regeneration,' T. H. Morgan.
- 'The Elimination of the Unfit,' H. C. Bumpus.
- 'Heredity of Coloration in Fishes,' Jacques Loeb.
- 'Do the Reactions of Lower Animals, Due to Injury, Indicate Pain Sensations,' W. W. Norman.
- 'North American Ruminant-like Animals,' W. B. Scott.
- 'Caspar Friedrich Wolff and the Theoria Generationis,' W. M. Wheeler.
- 'Animal Behavior,' C. O. Whitman.

MM. GEORGES CARRÉ and C. Naud have begun the publication of a series of scientific monographs under the editorial direction of leading French men of science. MM. Appell, Cornu, d'Arsonval, Friedel, Lippmann, Moissan, Poincaré and Potter are responsible for the physical and mathematical sciences and MM. Balbiani, d'Arsonval, Filhol, Fouqué, Gaudry, Guignard, Marey and Milne-Edwards for the biological sciences. The numbers so far issued are as follows: 'Les Oscillations Électriques,' by M. Poincaré; 'La Spécificité Cellulaire,' by M. Bard; 'La Sexualité,' by M. le Dantec.

SCIENTIFIC JOURNALS AND ARTICLES.

THE papers in the *American Journal of Science* for May are as follows:

- 'Some Experiments with Endothermic Gases,' by W. G. Mixter.
- 'Hypothesis to explain the partial non-explosive Combination of Explosive Gases and Gaseous Mixtures,' by W. G. Mixter.

'Occurrence of Paleotrochis in Volcanic Rocks in Mexico,' by H. S. Williams.

'Origin of Paleotrochis,' by J. S. Diller.

'Association of Argillaceous Rocks with Quartz Veins in the Region of Diamantina, Brazil,' by O. A. Derby.

'Goldschmidtite, a New Mineral,' by W. H. Hobbs ;
'Hydromica from New Jersey,' by F. W. Clarke and N. H. Darton.

'Powellite Crystals from Michigan,' by C. Palache.

'Volatilization of the Iron Chlorides in Analysis, and the Separation of the Oxides of Iron and Aluminum,' by F. A. Gooch and F. S. Havens.

'Descriptions of imperfectly known and new Actinians, with Critical Notes on other Species, V,' by A. E. Verrill.

'Preliminary Note as to the Cause of Root-Pressure,' by R. G. Leavitt.

'Study of some American Fossil Cycads, Part III,' by G. R. Wieland.

Professor L. V. Pirsson, who holds the chair of geology in the Sheffield Scientific School of Yale University, has become an associate editor of the *Journal* in the place of the late Professor Marsh.

AFTER the close of the current volume, in April, the *Zoological Bulletin*, edited by Professors Whitman and Wheeler, of the University of Chicago and published by Messrs. Ginn & Co., will be continued under the title the *Biological Bulletin* and be published under the auspices of the Marine Biological Laboratory. The scope of the *Bulletin* will be enlarged so as to include General Biology, Physiology and Botany. It will further include occasional reviews and reports of work and lectures at the Laboratory. The *Bulletin* will be open, as heretofore, to scientific contributions from any source.

SOCIETIES AND ACADEMIES.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 500th meeting of the Society was celebrated on April 15th by a dinner at Rauscher's. About fifty members were present. After coffee had been served, the President, Mr. O. H. Tittmann, in his usual felicitous manner, called on the past Presidents of the Society who had honored the banquet by their presence. Seven were present, namely, Newcomb, Harkness, Eastman, Dall, Clarke, Baker and Bigelow.

Interesting remarks were made by each gentlemen, on the past history of the Society, its relation to present scientific progress and its future sphere of usefulness. Informal conversation was had for a short time after a moment.

E. D. PRESTON.
Secretary.

ENTOMOLOGICAL SOCIETY OF WASHINGTON. APRIL 18, 1899.

UNDER the head of Exhibition of Specimens and Short Notes, Mr. Howard exhibited a full set of specimens of a species of a *Peripha* received from some unknown correspondent from Trinidad.

Mr. Schwarz showed a specimen of *C. erubescens* Bates. The determination was somewhat doubtful, but probably correct. The species is a distinct Central American form, but the specimens showed were from Madera Canyon, south Arizona. The insect is probably a grape feeder.

Dr. Dyar showed specimens of *Megathymus krugii*, Dew., collected by Mr. Busck in Mexico. The larva was described by Dewar in his original communication, but so brief that additional points were mentioned.

Mr. Howard asked whether Mr. Busck had been stung by this larva, and Mr. Busck replied that the first one which he found had fallen on the back of his hand and produced severe pain and inflammation which lasted three days.

The first paper of the evening was read by Mr. Schwarz and consisted of a continuation of the Hubbard correspondence from the Southwest. The letter read at this meeting contained a discussion of the insect fauna of *lirion wheeleri*. In discussion Mr. Pollard asked whether the agave and other large plants of that region have similar insect fauna. Schwarz replied that the agave is the liliaceous plant of that region which has a special enemy which attacks it when hatched. This is a lepidopterous larva of the genus *Megathymus*. The communication was then discussed by Messrs. Cockerell and Ashmead. Mr. Cockerell stating that two Coccids had been found upon the *Dasyilirion*, but that both species

were also found upon yuccas. Mr. Ashmead said that the *Dasytirion* insects were very similar in character to the insects found in decaying palmetto in Florida.

The next paper was by Mr. Marlatt, and in the absence of the author was read by Mr. Benton. It was entitled 'Remarks on some recent work on Coccidæ.'

L. O. HOWARD,
Secretary.

THE WASHINGTON BOTANICAL CLUB.

THE fifth regular meeting of the Washington Botanical Club was held April 5, 1899, at the residence of Mr. Frederick V. Coville.

Professor E. L. Greene made some remarks on the occurrence of parthenogenesis in *Antennaria*, apropos of Juel's recently published investigations in *A. alpina*. He considered the phenomenon to be well established in several of our native species.

Mr. J. G. Smith presented a synopsis of a proposed revision of the genus *Sitanion*, a group of grasses long included under *Elymus*. He was able to segregate a large number of new species, chiefly from Western localities.

Mr. H. J. Webber gave some notes on the various forms of *Zamia* found in Florida. There are apparently two well-marked species, at least on the east coast, one confined to the northern, the other to the southern half of the State, while on the west coast occurs possibly a third. Neither of these species is referable to *Z. integrifolia* Jacq., a name under which the plants have been described in most text-books. Mr. Webber exhibited numerous photographs, pointing out remarkable differences in the shape and structure of the fertile spike.

The Club extended invitations to the Philadelphia Botanical Club and to the Torrey Botanical Club of New York to visit Washington for a series of botanical excursions during the last week in May.

CHARLES LOUIS POLLARD,
Secretary.

SECTION OF ASTRONOMY AND PHYSICS OF THE NEW YORK ACADEMY OF SCIENCES.

A MEETING of the Section was held on April 10th, Professor M. I. Pupin, the Chairman of the Section, presiding.

A paper was read by Dr. A. S. Chessin on

'The Temperature of Gaseous Celestial Bodies.'

The author said, in brief, that, in view of some extravagant and baseless assertions which have appeared lately in both scientific and popular periodicals with regard to certain supposed laws of temperature in gaseous celestial bodies, it seemed proper to state the true condition of our knowledge in this direction. Dr. Chessin showed that what Dr. See assumed, in a recent article, to be a 'fundamental law' of nature, namely, the formula $RT = \text{a constant}$, in which $T = \text{the absolute temperature of the gaseous body}$ and $R = \text{the radius}$, was neither a 'fundamental' nor 'any law' at all; in fact, the formula is the result of erroneous and superficial calculations. Dr. Chessin also gave an account of the work done by others on the question of the temperature of heavenly bodies, particularly referring to the investigations of A. Ritter, in Wiedemann's *Annalen* for 1878. He showed how far from applicable to actual facts most of these theoretical discussions and calculations are, and he drew the conclusion that at this stage of our knowledge it would be but an idle speculation to formulate any law which may govern the changes of temperature in heavenly bodies. He called attention to one interesting case discussed by Ritter in his theoretical investigations, a case in which when γ , or the ratio of the specific heat at constant pressure to that at constant volume, is greater than $4/3$, we could have a pulsating condition of the gaseous body about a condition of equilibrium. A *résumé* of Ritter's work appears in Exner's *Repertorium* for 1884. Betti, of Pisa, has discussed the same problems and obtained the same results.

In the discussion Professor Pupin said that in the contraction of a heavenly body the work done by gravitation might be an excessively small fraction of the total work done by all the forces, including the so-called forces of chemical affinity, which we usually consider are due to electrical forces. But we cannot at present base any calculations on these, as we know so little about them.

Professor Rees said that if astronomers cannot yet solve these problems, it is because they cannot get the proper knowledge from the physicists on the physical parts of the question.

Mr. W. C. Kretz read a paper on the 'Positions and Proper Motions of Stars in Coma Berenices from Rutherford Photographs.' Rutherford took fourteen photographs in the years 1870, 1875 and 1876 of the cluster in Coma Berenices. The positions of these stars on the plates were measured with a Repsold measuring machine, and the reduction was made by the method worked out by Professor Jacoby. Great precautions were taken to eliminate all possible errors. The positions obtained were compared with those obtained by Chase with the Yale heliometer in 1892. In this manner a catalogue of the positions and proper motions of twenty-four stars was obtained, which was the object of the research.

WM. S. DAY,
Secretary.

THE NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY.

THE regular monthly meeting of the New York Section of the American Chemical Society was held at the Chemists' Club, 108 West Fifty-fifth street on Friday evening, April the 7th; Dr. Wm. McMurtrie presiding, and about sixty-five members present.

The following papers were read: 'The Toxic Action of Sodium Fluoride,' by H. B. Baldwin. 'The Chemistry of the By-Products of Coke Ovens,' J. D. Pennock. 'Notes on the Chemistry of the Carbides,' J. A. Matthews. 'The Distribution of Alkali in Montana,' F. W. Traphagen and W. M. Cobleigh; read by Mr. Cobleigh.

Mr. Baldwin said that, owing to the now somewhat extended use of sodium fluoride in the arts and as a preservative and insecticide, there is considerable liability of accidental poisoning from the substance. Several cases are cited with the symptoms observed, the most prominent of which are nausea and vomiting within a few minutes. One case resulted fatally from an unknown dose, probably about ten grams. Five grams produced serious results in another case. The author took several experimental doses and was made ill by 0.25 gram. A case is also cited where about 50 grams were taken with complete recovery. The literature of the substance as a toxic agent is very meagre,

but experiments have been made by several German and French investigators. Shultz found that by subcutaneous injection the lethal dose per kilogram of body weight was for rabbits 0.2-0.4 gram, for dogs 0.3 gram and for frogs 0.005-0.006 gram. Sodium fluoride should be classed among the less violent poisons and ought to find a place in works on toxicology.

The paper of Messrs. Traphagen and Cobleigh was an interesting description of the distribution of alkali in Montana with analytical data.

Professor Matthews gave a classification of the carbides thus far known, according to their methods of preparation and properties, and described their commercial development, beginning with carborundum, of which in 1895 the production was about 300 pounds per diem. Last July the daily output was 4,300 pounds and over. It is said to be harder than emery and lighter. It has been successfully used in plate-glass grinding, as well as for all ordinary purposes. Recently it has been put to an entirely new use, that of furnishing silicon to steel, being a substitute for ferro-silicon where the addition of some carbon is not objectionable.

The calcium carbide industry was also reviewed, and several uses other than for preparation of acetylene were mentioned, as follows: Drying alcohol and other organic liquids, absolute alcohol being easily prepared by its use; to deoxidize and carbonize iron, and as a reducing agent in fire assays. Moissan has used it as a reducing agent in the preparation of other carbides.

Mr. Pennock's paper gave interesting particulars out of the construction of the coke ovens at Syracuse, N. Y., with details of the percentages of bye-products, composition of the gas, tar, etc., closing with lantern views of the exterior and interior of the buildings, showing the retorts and other important parts of the plant.

DURAND WOODMAN,
Secretary.

DISCUSSION AND CORRESPONDENCE.

MESSRS. LEHMANN AND HANSEN ON TELEPATHY.

TO THE EDITOR OF SCIENCE: One or two of your readers may possibly remember a small exchange of words between Professor

Titchener and myself *apropos* of his article in SCIENCE for December 23d (Vol. VIII., p. 897).

Messrs. Lehmann and Hansen had sought to show experimentally that the results of certain experiments by Professor H. Sidgwick, which the latter had ascribed to 'thought-transference,' were really due to involuntary whispering by the agent, overheard hyperæsthetically by the subjects. Professor Titchener closed his article by saying: "The brilliant work of Messrs. L. and H. has probably done more for scientific psychology than could have been accomplished by any aloofness, however authoritative."

To these words I, in your next number, took exception, saying that if Professor Titchener would read Sidgwick's and my criticisms of the work of the Danish investigators, he would probably agree 'that, owing to the fewness of the data which they had collected, they entirely failed to prove their point.' I, consequently, called their essay 'an exploded document'; to which my 'scientifically-minded' *confrère* rejoined (in SCIENCE for January 6th) that he had carefully read the criticisms, and had thus seen us 'handling the fuse,' but that he had 'not yet heard the detonation.'

As the explosion was so audible to me, the disproof being quasi-mathematical, I was astounded at this hardness of hearing in my colleague; and, to make sure that I was not a victim of auditory hallucination, I wrote to Professor Lehmann to know what he himself thought of his conclusions, in the light of the criticisms in question. His answer, somewhat belated, just arrives.

He says: "Your own as well as Professor Sidgwick's experiments and computations prove, beyond a doubt, that the play of chance had thrown into my hands a result distinctly too favorable to my theory, and that the said theory is consequently not yet established (*bewiesen*)."

This is identically Professor Sidgwick's and my contention; and for his candor, as well as for his willingness to take pains to experiment in this region, Professor Lehmann deserves to stand high as a 'psychical researcher.'

Professor Titchener, meanwhile, still hugging the exploded document, wanders upon what he

calls 'the straight scientific path,' having it apparently all to himself. May the consciousness of his fidelity to correct scientist principles console him in some degree both for his deafness and for his isolation.

WILLIAM JAMES.

CAMBRIDGE, April 20, 1899.

TWO CORRECTIONS.

My attention has just been called to this paragraph in SCIENCE, June 3, 1898, p. 784, foot of column two:

"*Erratum*: In the review of Wilder's System of Nomenclature, p. 716, col. I, line 5, for 'chippocamp' read 'hippocamp.'"

This prompt public correction renders needless and unjust the commentary upon the subject in my address last December before the Association of American Anatomists (*Proceedings*, p. 83, and SCIENCE, April 21, 1899, p. 577), and I deplore my non-acquaintance with it up to the present time. Since none of those who heard my address reminded me of the 'Erratum,' it seems to have been overlooked by them also.

In this connection may properly be corrected a typographical error in the address itself (*Proceedings*, p. 16, and SCIENCE, April 21, 1899, p. 566, note, title 6); the date of publication of the 'Review' in SCIENCE should be May 20th, not 28th.

These corrections will be incorporated in the *Proceedings* and sent to those who receive copies of SCIENCE from me.

B. G. WILDER.

ITHACA, N. Y., April 26, 1899.

[It may be explained the typographical error referred to above was not due to any oversight on the part of the writer of the review. An inverted comma (') was inserted in the proof before hippocamp, which was mistaken by the printer and the proof reader for a c.—ED. SCIENCE.]

NOTES ON PHYSICS.

A NEW THEORY OF THE ZEEMAN EFFECT.

DURING the last eight or ten years Goldhammer has published at intervals in *Wiedemann's Annalen* a series of papers dealing with the electro-magnetic theory of light, and espe-

dially upon the transmission of light through ordinary media. The chief difference between his treatment of the subject and the classical one of Maxwell lies in the fact that Goldhammer considers what are usually called the *constants* of the medium, the specific resistance or the dielectric constant, for instance, not to be *constants*, but to be *functions of the wave frequency, developable in power series*. It may be remarked that this view receives a certain amount of support from the researches of Blondlot and J. J. Thomson, which show that the dielectric constants of certain materials do depend upon the frequency.

Developing mathematically the preceding hypothesis, Goldhammer arrives at very general equations for the velocity and absorption of light in a given medium. It is worthy of remark that the formulas given by Helmholtz, Sellmeier and Lommel can all be considered as special cases of that of Goldhammer and can be derived from it.

In *Wied. Ann.*, No. 3, Band 67, Goldhammer applies the theory which has just been sketched to the Zeeman effect, and thus obtains a new theoretical explanation of the phenomenon. Considering the absorption spectra first, he shows that any alteration in the specific constants of the medium will cause a change in the position of the absorption lines. He then assumes that the magnetic field does cause such an alteration in these quantities; in support of this assumption, he calls attention to a paper by Boltzmann (*Wied. Ann.*, 31, p. 789), in which it is shown that a magnetic field increases the resistance of a gas placed in it.

Kirchoff's laws allow one to pass from the absorption spectrum to that of emission. Then in a bright-line spectrum the effect of a magnetic field is to cause displacements in the lines and might give rise to doublets and triplets.

In order to account for the polarization phenomena, Goldhammer makes a further assumption that the magnetic field causes the medium to become *æleotropic* and double-refracting. The circular polarization of the doublets, when viewed along the lines of force, is very closely connected with the well-known magnetic rotation of the plane of polarization.

It will be noticed that this theory of Gold-

hammer's differs materially from the one proposed by Lorentz and Larmor. Goldhammer makes the whole of the phenomena depend upon changes in the medium, while Lorentz and Larmor attribute them to the electric and magnetic forces developed by the motion of electrified ions in a magnetic field.

At present it seems that the ionic is the more promising of the two theories, since it gives a more complete explanation, incomplete it is true, of the complexity of structure of the lines and of the polarization. The numerical value of the ratio between the mass of a vibrating ion and the charge carried by it as derived from the Zeeman effect is in good agreement with that obtained by J. J. Thomson from the phenomenon of cathode rays.

DAYLIGHT-PHOSPHORESCENCE.

MOURELO (*Comptes Rendus*, t. CXXV, p. 557) has made the curious discovery that certain sulphides of strontium, calcium, barium, zinc, prepared in a particular way, exhibit much more brilliant phosphorescence after exposure to diffused daylight than after exposure to direct sunlight, and, if that periodic exposure to diffused daylight continues very remarkably the power of phosphorescing. After being brought to this sensitive state one phosphorescing portion excites phosphorescence in another non-phosphorescent portion either when the two portions are in contact or when they are contained in separate glass tubes.

A. ST. C.

NOTES ON INORGANIC CHEMISTRY.

AN analysis of the water of the Great Iceberg Glacier, British Columbia, has been published in the *Chemical News* by F. T. Charron and A. T. Charron. The waters were taken a few feet from the face of the glacier, and of characteristic turbid or milky appearance. Analysis showed water of great organic purity, the free ammonia being 0.018 parts per million, albumenoid ammonia 0.027 to 0.037; nitrate as nitrates and nitrites 0.0246 to 0.0346; chlorine 0.1; solids 12 to 30.8. On sedimentation the waters became perfectly clear, microscopic examination of the deposit showing

it to be very fine rock matter, chiefly fragments of quartzite.

AN analysis of an artesian water from Derbyshire is given by John White in the *Analyst*, which is peculiar as containing barium, it being the first recorded occurrence of this metal in waters in this section. The well is 1,300 feet deep and 160 feet above the sea level. According to the analysis given, the water first obtained at depth of 837 feet, contained of barium carbonate 1.77 parts per 100,000; the deep water contained at first of barium chlorid 38.55 parts, and six months later 40.7; water eighty feet below the surface contained 3.03 parts. The sodium chlorid in the deep water was over two thousand parts. The author discusses the origin of the barium salt. Clowes has found minute crystals of barium sulfate in the red sandstone near Nottingham, and Dieulafait has shown barium to be a constant constituent of primitive rocks, but this does not explain the conversion of the sulfate into carbonate or chlorid. The only possible explanation, according to the author, is that the barium sulfate has been at high temperature reduced to the sulfid by coal, and this converted into the chlorid by concentrated salt solution. The carbonate is derived from the chlorid. In confirmation of this it is pointed out that barium sulfate has been found in connection with coal deposits and barium chlorid in water in the vicinity of coal mines. It is, however, not impossible that under certain conditions, such as Melikoff has shown take place between sodium sulfate or sodium chlorid and calcium carbonate in the presence of aluminum or ferric hydroxid, a reaction may take place between the barium sulfate and sodium chlorid in a concentrated solution of the latter.

PROFESSOR VÈZES, of Bordeaux, has continued his work upon the oxalates and nitrites of the platinum metals, and his last contribution to the *Bulletin Société Chimique* is on the complex salts of palladium. A concentrated solution of potassium chloropalladite is converted by potassium oxalate into the pallado-oxalate, and the same salt is formed by the action of oxalic acid upon the pallado-nitrite. On the other hand, the pallado-oxalate is readily converted into the chloropalladite by

hydrochloric acid, and into the pallado-nitrate by potassium nitrate. These reactions correspond very closely to those of the platinum salts as investigated by Vèzes, except that only one modification of the pallado-oxalate has been found. The pallado-oxalic acid was also obtained and found to be tolerably stable.

The same journal contains analyses of a series of potassium, ammonium and silver salts of the so-called osmiamic acid, by Brizard, in which the formula proposed by Joly for this acid is fully confirmed. According to this, osmiamic acid is a nitroso compound, having the formula $\text{OsO}(\text{NO})\text{OH}$, and corresponds to nitroso hydroxid of ruthenium.

J. L. H.

CURRENT NOTES ON METEOROLOGY.

BLUE HILL OBSERVATORY BULLETINS.

BULLETIN No. 2 (1899) of Blue Hill Observatory, prepared by A. E. Sweetland, contains accounts of two remarkable snow storms which occurred during the past winter. The first storm, that of November 26-27, 1898, caused the wreck of 141 vessels on the New England coast, and the loss of 280 lives. It was during this storm that the steamer *Portland*, with about 175 persons on board, was lost off Cape Cod. The suddenness and violence of this storm were due to the rapid increase in energy which took place when a cyclone from the Gulf of Mexico and one from the Great Lakes met on the coast. The fall of snow was very heavy. On February 8-14, 1899, a severe cold wave and another heavy snowfall occurred. On February 13th, at 8 a. m., the zero isotherm extended as far south as latitude 31° . At Blue Hill the average temperature of the five days February 8-13 was 3.1° lower than the average of any successive five days since the Observatory was established. This cold wave was followed by a heavy snow storm, with high winds, along the North Atlantic coast. It is interesting to note that the preceding cold wave, although it caused much suffering by its severity at the time, had one very fortunate effect. The extreme cold which had almost closed some of the harbors with ice, and the difficulty of navigation when the waves, driven by the strong westerly gale, quickly

froze on decks and rigging, had resulted in keeping many vessels in port. In consequence, but few lives were lost at sea.

Bulletin No. 3, by S. P. Fergusson, is entitled *Progress of Experiments with Kites during 1897-98 at Blue Hill Observatory*, and presents an admirable summary of this work. Both Bulletins are abundantly illustrated.

SNOW ROLLERS.

THE March number of *Climate and Crops: New England Section* notes the occurrence of 'Snow Rollers' at Grafton, N. H., on March 16th, last. This is an interesting but comparatively rare phenomenon, occasionally observed in the winter season when freshly fallen snow is rolled into balls or cylinders by the wind. At Grafton these are stated to have been rolled up in countless numbers. Some of the rollers were as large as a barrel, and the fields and hills were covered with them. Other occurrences of the same phenomenon have been noted, within recent years, at Spokane, Wash., in December, 1895; at Hartford, Conn., on February 19, 1896, and in Saline county, Kan., on January 14, 1898. At Spokane there were 'hundreds of snow cylinders of uniform size, and as perfectly formed as though they had been cast in a mould.' The rollers were from 12 to 16 inches long, and from 6 to 10 inches in diameter. At Hartford some of the rollers measured 8 inches in diameter. In the Kansas case the size varied from that of base-balls to that of half-a-bushel measures. The uniform size, often noted, may be explained by the fact that the wind rolls the cylinders of snow along the ground until they become too heavy to be moved farther. If the velocity of the wind continues about the same it is likely, other things being equal, that the rollers will have about the same size.

A COURSE IN METEOROLOGY AT OHIO STATE UNIVERSITY.

It is a pleasure to note the establishment of a new course in meteorology at the Ohio State University, Columbus, Ohio. This course, which is being given by Mr. J. Warren Smith, Section Director of the U. S. Weather Bureau at Columbus, is required in the junior year in

the course in agriculture and horticulture. It is elective in the courses in arts, philosophy and science. It is also open to all teachers. It began on March 29th, and is given twice during a term of ten weeks. The object of the course, as stated in the prospectus, is 'to present and outline a rational and systematic study of the leading facts concerning our atmosphere, and of the methods of observing and investigating the daily weather changes, the physical laws underlying these changes, and the application of these laws to the study of Davis's 'Elementary Meteorology' is used as a text-book. The lectures are illustrated by lantern views, and the 'laboratory work' includes the use of the ordinary instruments and practice in the construction of weather maps.

CLIMATE OF THE CONGO FREE STATE.

THERE has recently been published an admirable little pamphlet on the climate of the Congo Free State, by M. Lancaster, Director of the Meteorological Service of Belgium (*Court du Climat du Congo*, 12mo., Brussels, 1899, 43). This is a summary, in a very convenient form, of the meteorological portion of a large volume on the climate, soils and hygiene of the Congo Free State, noticed in *SCIENCE* for January 13, 1899, p. 72, and is reprinted from *Annuaire de l'Observatoire royal de Belgique*, 1899.

R. DE C. W.

HARVARD UNIVERSITY.

A NEW MARINE BIOLOGICAL LABORATORY.

AMERICAN biologists will doubtless be glad to learn that the United States Fish Commission will maintain a marine biological laboratory at Beaufort, N. C., during the summer, and will probably undertake to establish a permanent laboratory at that place. The station will be fully equipped for a large number of investigators and be ready for occupancy by June 1st. There will be one building devoted to laboratory purposes and another for sleeping accommodations.

Dr. H. V. Wilson, professor of biology at the University of North Carolina, has been appointed to become the director of the laboratory. Dr. Wilson was associated with the Commission at its Woods Hole laboratory for several

and needs no introduction to the scientific world.

Beaufort is situated near one of the great ocean inlets, and the waters of the harbor and adjacent sounds are remarkably well supplied with fishes and invertebrates. The advantages this locality affords for biological research are well known, as many naturalists have from time to time resorted thereto for the study of special problems.

In the early fall Beaufort will be made the headquarters of the steamer *Fish-Hawk* during a biological and topographical survey of the oyster grounds of the State which the Commission will conduct at the request of Professor J. A. Holmes, director of the North Carolina Natural History and Geological Survey, and other State officials.

HUGH M. SMITH.

U. S. COMMISSION OF
FISH AND FISHERIES.

THEORY OF THE STEAM ENGINE.

M. NADAL, in a very extended review of the recognized 'Principles of the Mathematical Theory of the Steam Engine,' in recent issues of the *Revue de Mécanique*, discusses the theory of heat-exchanges between working fluid and cylinder-walls, the influence of the duration of the admission period, that of the compression and of the velocity of operation of the motor; touching upon the experimental work of Dwelshauvers-Dery. His principal conclusions are the following:*

1. The absorptive power of the metal in contact with the vapor is finite, and variable as a function of time. It is more considerable than the emissive power. The variation of this absorbing power is a function of the amount of liquid deposited upon the wall, and that amount has been shown by Donkin to vary, in the cases reported by him, from 20 calories per square meter per unit difference of temperature between metal and vapor, per second, and, at the time of admission, down to 12 during expansion and lower, and to 2 during the period of re evaporation and of emission, and to even less values as exhaust becomes complete; although this re-evaporation may be

* *Revue de Mécanique*, 1898-9.

exceedingly rapid at the moment of opening the eduction port.

2. In the case of the unjacketed cylinder the mean temperature of the wall is equal or superior to that of the vapor in contact with it.

3. The heat surrendered by the vapor at induction increases less rapidly than does the period of action, that of induction. The indications are that the range of temperature during expansion mainly affects the quantity of the heat-exchange and that the total temperature-range does not measure the waste, which is contrary to general opinion among engineers and physicists.

4. Compression in the clearance or 'dead spaces' is not always advantageous.

M. Nadal shows that the moisture on the wall plays an important part, augmenting the quantity of heat-waste as superheating diminishes it. It is found that the variation of the magnitude of heat-exchanges during the forward and the return stroke accounts largely for the well-established, and often large, gains due to the use of the steam-jacket; since that accessory may communicate heat rapidly and effectively during the earlier portion of the cycle, while the sluggish transfer of heat out of the cylinder wall during the period of low pressure and temperature checks the wastes that would otherwise then occur, and more extensively than in the earlier period. Thus this variation of transferring power of the wall acts as a sort of 'check-valve' for the heat received from the jacket, permitting it to act efficiently, where most needed and preventing loss of heat where its transfer could do no good and would be purely a waste. Thus the jacket, also, is most economical in those engines which would be most economical without it, those in which the interior walls of the cylinder are dry during exhaust.

R. H. THURSTON.

THE PHILADELPHIA EXPOSITION OF 1900.

WE have received from the officers of the Philadelphia Exposition of 1900 details in regard to their plans. It is their purpose to exhibit every kind of manufactured products of the United States especially suitable for export. Such exhibits will form the principal depart-

ment of the Exposition and will comprise everything which is, can or might be exported, from locomotives and heavy machinery to the smallest novelties.

There will also be a department of foreign manufactured goods, but it will not contain a single exhibit shown by a foreign manufacturer. This department will consist of collections of samples of goods made in the commercial countries of Europe and successfully sold in all foreign markets in competition with American goods and in foreign markets in which American trade has not yet been developed. These samples will be exhibited side by side with American products of the same class, and will show our manufacturers just what competition they must meet abroad, as well as the peculiarities in the demands of every foreign market.

A third department of the Exposition will show how American goods must be packed, labeled and shipped in order to meet the requirements of foreign trade, which vary according to the degree of development or civilization in each country of the world.

In October a Commercial Congress will be held in Philadelphia in connection with the meeting of the International Advisory Board of the Philadelphia Commercial Museums. There is every reason to believe that at least 800 representatives of foreign firms will be present at the sessions of the Commercial Congress and in attendance on the Exposition, in addition to the official delegates and those representing commercial organizations.

The Exposition will be under the joint auspices of the Philadelphia Commercial Museums and the Franklin Institute. Sanction and support has been given to the Exposition by the National Government, Congress appropriating \$350,000 to aid it. The City of Philadelphia has given \$200,000, and the State of Pennsylvania \$50,000, and \$100,000 is being raised in Philadelphia by individual subscriptions.

The main buildings, which are now under construction, cover eight acres of ground, and the available exhibition space will be at least 200,000 square feet. Outside of the space occupied by the main buildings there will be within

the Exposition grounds, which comprise of fifty-six acres of land on the bank Schuylkill River, within fifteen minutes of the City Hall, ample space for the erection of detached structures for special exhibits.

SCIENTIFIC NOTES AND NEWS

VICE-PRESIDENT BRANNER, of Stanford University, will conduct an expedition to Brazil during the summer to work upon the geology, stone and coral reefs of the coast. These more or less broken, extend from Ceará to Abrolhos, a distance of more than a thousand miles. Dr. Branner did much work upon reefs while he was connected with the Geological Survey of Brazil, but the field observations were never finished and the results of them were not published. He hopes to complete his work during the summer vacation. Expenses of the expedition will be paid by Professor Alexander Agassiz, and the results will be published by the Museum of Comparative Zoology at Harvard.

PRINCETON proposes to send a small party to observe the total eclipse of the sun which occurs on May 27, 1900. A friend of the University has provided the necessary fund for the special apparatus that will be needed, already being constructed. The station occupied is not yet finally selected, but probably be near the boundary between North and South Carolina, where it is crossed by the track of the moon's shadow, running northward from New Orleans to Norfolk, Va.

THE Iron and Steel Institute of Great Britain has conferred the Bessemer Gold Medal in 1899 on Queen Victoria in commemoration of the great progress made in the iron and steel industries during her Majesty's reign.

THE Academy of Sciences at Halle has elected Dr. Hans Lenck, professor of mineralogy at Erlangen, to membership.

SIR JAMES WRIGHT, C.B., late Engineer-in-Chief of the British Navy, to whom many of the improvements in British warships are due, died on April 16th in his 86th year.

THE death is also announced of Sir William Roberts, F.R.S., the eminent London physi-

at the age of 69 years. He gave the Goulstonian, Lumleian and Croonian lectures and the Harveian oration before the Royal College of Physicians, and contributed in many ways to the advancement of medical science and education.

WE regret also to record the deaths of Professor Karl Scheibler, the chemist at Berlin, aged 72 years; of Dr. Josef Wastler, docent in geodesy in the Technical Institute at Graz, and of Dr. H. A. Wahlforso, professor of chemistry at Helsingfors, at the age of 60 years.

A CABLEGRAM from Constantinople states that in order to develop the agricultural resources of the empire, the Sultan has consulted with the United States Minister, Mr. O. S. Straus, in regard to securing the services of two American agricultural experts, who will be attached to the Ministry of Mines, Agriculture and Forests.

MR. JOHN HAMILTON has been appointed Secretary of Agriculture for the State of Pennsylvania by Governor Stone in the place of Mr. Thomas J. Edge, who has been compelled to resign. It is said that this change has been made for political rather than for scientific reasons.

A CIVIL SERVICE examination for the position of Computer in the Division of Forestry, Department of Agriculture, at a salary of \$1,000 per annum, will be held on May 16th and 17th. The examination is chiefly on computation in forestry.

AT the annual meeting of the California Academy of Sciences officers and trustees have been elected to fill the various offices in the Academy for the ensuing year as follows: President, William E. Ritter; First Vice-President, Chas. H. Gilbert; Second Vice-President, H. H. Behr; Corresponding Secretary, J. O'B. Gunn; Recording Secretary, G. P. Rixford; Treasurer, L. H. Foote; Librarian, Louis Falkenau; Director of the Museum, Charles A. Keeler; Trustees, William M. Pierson, George C. Perkins, C. E. Grunsky, William H. Crocker, George W. Dickie, E. J. Molera, James F. Houghton. The yearly report of the President, William E. Ritter, showed the past year to have been one of earnest activity in the various working departments. The necessity is urged of concentrating the efforts and the funds of

the Academy toward making complete the natural history collections of the State. Especial stress is laid upon the desirability of exploring the waters of the Pacific that wash the California coast, and collecting into the store-cases and exhibition galleries of the Museum the scientific treasures of these waters. The report mentions the gratifying commendation which the improved style in which the *Proceedings* are issued calls forth from both at home and abroad. Here may be mentioned the highly appreciated gift of \$1,000 given to the publication fund by Mr. C. P. Huntington. The report of the Librarian gives the number of volumes in the library as nearly 10,000. The crowded meetings held twice each month evince the public interest in the popular scientific lectures, which are open to all. The principal event of the year was the definite movement, appropriately initiated by the Society of California Pioneers and heartily participated in by the Academy, to secure from the State Legislature funds for the erection of a statue to the late James Lick, to whom the Academy owes an ever-growing debt of gratitude for his beneficent gift to the institution.

THE fourteenth annual meeting of the Association of American Physicians will be held at the Arlington Hotel, Washington, D. C., on May 2d, 3d and 4th.

THE annual meeting of the Iron and Steel Institute of Great Britain will be held on May 4th and 5th. Sir William Roberts-Austen, the President-elect, will give an inaugural address, and a program has been arranged that includes papers by representatives from the United States, Austria, Russia, Spain and Sweden.

THE Council of the Royal College of Surgeons has decided to celebrate the centenary of its foundation between March 22 and June 30, 1900. The College is also considering the advisability of applying for power to grant at the time diplomas of honorary fellowships, of which not more than fifty shall be conferred.

PLANS are being made for the establishment of an institute of bacteriology and experimental medicine at Bucharest.

THE Prince of Monaco is building at Monaco a Museum of Oceanography to contain the col-

lections made by the expeditions of the yacht *Princess Alice*. It will contain not only exhibition rooms, but also laboratories for the use of men of science who wish to work upon the collections. The Museum will, in addition, represent the relations of meteorology to navigation.

THE conferences established three years since by Professor Milne-Edwards for the instruction of explorers and travelers have been resumed in the Paris Museum of Natural History. A number of the professors of the Museum take part, explaining the methods of collecting and preserving plants, animals, etc., of making maps and photographs, hygienic precautions, etc.

THE *Critic* of May publishes, over the name of Professor O. C. Marsh, the portrait of Professor F. A. March, of Lafayette College, the eminent philologist. The account of the late Professor Marsh accompanying the portrait opens as follows: "This excellent portrait of the distinguished paleontologist, whose unpaid service at Yale College did so much to strengthen the position of that University in the educational world, was made in this city only about a year ago. Professor Marsh himself was greatly pleased with it."

AT the last monthly general meeting of the Zoological Society, London, Lieutenant-Colonel L. H. Irby in the chair, it was stated that there were 83 additions made to the Society's menagerie during March, amongst which special notice was directed to a kiang, or wild ass of Tibet (*Equus hemionus*). Only two examples of this scarce animal had been previously exhibited in the Society's gardens—namely, in 1859 and 1885. There had also been received an example of Pel's owl (*Scotopelia peli*), a rare species of owl from the Niger territory, presented by Lieutenant E. V. Turner, R.E., and a Cape jumping hare (*Pedetes capter*), presented by Mr. William Champion, F.Z.S.

In an important paper read by Mr. Charles Heycock before the Royal Institution, recently, a study of the method of union of the constituents of alloys is followed which indicates that the same laws control as in solutions. Gold, for example, dissolves in melted silver, and the temperature of solidification is reduced in proportion to the weight of gold introduced, until

a limit is approximated with twenty gold. This 'law' is verified in the case of a number of alloys mentioned, but not with others (as Sb in Bi). The rate of low temperature in the cases illustrating is inversely proportional to the square of the weights of the dissolved metal.

SIGNOR MARCONI has successfully communicated from the South Foreland, Kent, French armed despatch vessel *Ibis* while in the English Channel.

THE scientific library of the late Dr. Britton, F.R.S., the entomologist, has been sold at auction at London. The following works were included: 'Annals de la Société Entomologique de France,' from the beginning in 1832—£35; J. Curtis, 'British Entomology,' 1835—£11 5s.; Transactions of the Entomological Society of London, from the beginning to 1892, 38 volumes—£32; P. Millière, 'Ographie et Description de Chenilles et de Lépidoptères Inédits,' 1859-74—£10 5s.; G. Herrick-Schäffer, 'Systematische Bearbeitung der Schmetterlinge von Europa,' 1843-50—£10s.; and J. Hübner, 'Sammlung Europäischer Schmetterlinge,' Augsburg, 1805, etc., £

IN his presidential address before the Royal Society, London, Professor Dewar, reported in the *London Times*, discussed the means that might be used for measuring a range of temperature between the critical temperature of hydrogen and the zero of absolute temperature. The electrical resistance thermometer was of great delicacy, but it depended upon knowledge of the law connecting resistance and temperature and involved the necessity of extrapolation. At such temperatures, however, conditions occurred which could not be trusted, and hence no confidence could be placed in the results given by the curve. Platinum, for instance, which was frequently used for the construction of such thermometers, approaches its zero of resistance when immersed in hydrogen, and theoretically only requires to be cooled five or six degrees further to become a perfect conductor of electricity. Such a condition should be effected by making the hydrogen boil under exhaustion, but, in fact,

lowering of temperature indicated by the platinum thermometer in such circumstances did not exceed one degree. Hence the platinum must have come to a limit. Two pure platinum thermometers which Professor Dewar had tried both behaved in this way. Next he experimented with a resistance composed of an alloy of rhodium and platinum, which gave a different temperature altogether. According to it the boiling point of hydrogen was *minus* 246° as against *minus* 238° shown by the pure platinum arrangement, and it, too, failed to indicate the expected lowering under exhaustion. A thermo-junction of iron and German silver was next tried without satisfactory results, and another junction of lead and iridium-platinum proved equally ineffective. Thus he was brought to an air thermometer and the use of hydrogen itself under diminished pressure to determine its own boiling point. In the instrument he had constructed the gas had a tension of 273 mm. at the temperature of melting ice, so that a difference of one millimeter, corresponded to one degree of temperature. The boiling point of hydrogen was by this thermometer given as about *minus* 252°, but various corrections had to be made, and in particular the possibility of the hydrogen being contaminated with a slight impurity of air or oxygen allowed for, so that it was uncertain what exactly was the true boiling point. Assuming it to be *minus* 252°, or 21° on the absolute scale, Professor Dewar went on to illustrate the difficulties of nearer approach to the absolute zero itself. By exhaustion the experimenter could not practically get more than 6° lower, and at that point he was barred and blocked with no means of bridging over the remaining 15°. Even supposing that a new substance was discovered as volatile in comparison with hydrogen as hydrogen was in comparison with nitrogen, that under exhaustion would only give a temperature 3½° above the zero, and it would require a second hypothetical substance as volatile compared with the first as the first was compared with hydrogen to enable the experimenter to come near the extreme of temperature he is aiming at.

THE report by Sir William Crookes, F.R.S., and Professor Dewar, F. R. S., on the composition and quality of daily samples of the water

supplied to London for the month ending February 28, 1899, says: We have again to record an excess of rain. The rainfall at Oxford during the past month was 1.92 in., the average fall for the last 30 years is 1.76 in., giving an excess of 0.16 in., and making the excess for the first two months of the year 0.85 in., or 21.6 per cent. on the average fall. It is interesting to observe the effect of the rainfall on the number of microbes in the unfiltered Thames water. No rain fell on the 1st, 2d or 3d, and the average number of microbes in the Thames at Hampton up to the 4th was 6,510 per c.c.; it then rained every day until the 15th, during which time the average number of microbes, including the 16th, rose to 38,354 per c.c.; after the 15th no more rain fell, and the average number of microbes from then to the end of the month fell to 14,914 per c.c. This large increase in the number of microbes in the river, due to rain, originates not merely from the washing of the surface of the land, but is also largely due to atmospheric microbes brought down by the rain. As far as our experiments go they are perfectly harmless. During the month the London waters, chemically and bacteriologically, have maintained their high character as an efficiently filtered river supply.

PROFESSOR E. RAY LANKESTER has written a letter to the *London Times* stating that £3,240 have been subscribed toward a second expedition of Mr. J. E. S. Moore to Lake Tanganyika, and that in addition £500 have been offered on condition that a further sum of £500 be collected. This insures the sending of the expedition regarding the scientific importance of which Professor Lankester writes: Some ten years ago the discovery of a true medusa—similar to some marine jelly-fish—in the waters of Lake Tanganyika led naturalists to entertain the notion that this vast and remote inland sea might retain within its area other evidences of a former connection with the ocean. The medusa (which swarms in the lake at certain seasons) was duly described by Mr. R. T. Günther in my laboratory at Oxford, and named *Limnocoñida Tanganyikæ*. So great was the interest felt in the suggestions to which its presence gave rise that I obtained two small

grants from the Royal Society and the British Association, and was fortunate enough to induce Mr. J. E. S. Moore to undertake, in 1896, a journey to Lake Tanganyika in order to collect the fish, shell-fish, medusæ and sponges which occur in its waters. The result of Mr. Moore's careful study of his collections (especially by the examination of the internal anatomy of the whelk-like shell-fish obtained) has been to show that there is in Lake Tanganyika an ordinary fresh-water lake fauna similar to that of other lakes, but that side by side with this there is a second fauna of marine character to which Mr. Moore has given the name 'halolimnic' (oceanolacustrine). Not only this, but Mr. Moore has shown that the molluscs of the halolimnic fauna of Tanganyika have an extraordinary resemblance to forms occurring in the fossil condition in the inferior oolites of Europe. I have recently placed in the northeast recess of the central hall of the Natural History Museum in Cromwell-road a case showing a series of these Tanganyika shell-fish side by side with examples of the oolitic shells with which they so closely agree. Close to these are placed the fishes brought home by Mr. Moore, of which 26 were new to science. Mr. Moore, in his former visit to Tanganyika, was not able to do more than 'scratch round some 150 miles of the shallow coast line of a lake over 350 miles in length' (to use his own words). Naturally one is led to believe that a more thoroughly equipped expedition with the use of a steamer on the lake (which Mr. Moore had not the chance to obtain) would yield results of proportionately increased importance. It is not merely as adding new forms to our collections that such an exploration is to be desired. The great geological problems of the history of this lake basin and its connection possibly with the Nile or a northward sea, possibly with an ancient estuarine Congo, are what stare us in the face. There are deposits in the valley north of Tanganyika and in its immediate vicinity which must be examined and infallibly yield evidence on these subjects. There are also the northward lakes of Kivu and the Albert Edward Nyanza, the waters of which have never been sampled for their living witnesses of geological history.

UNIVERSITY AND EDUCATIONAL.

WE announced last week that Mr. A. the Russian engineer, had left, under conditions, 1,000,000 roubles for the foundation of a university for women at Moscow; trust has been accepted by the Moscow pality and an annual subsidy of 3,000 has been voted.

THE medical library of the late I. mund Waterman, of New York, has been bequeathed by him to Yale University.

A FRIEND of Princeton University whose name has not been disclosed has given 10,000 to establish a chair of politics. It is reported that the chair is for ex-President Cleveland.

PROFESSOR H. P. HUTCHINS, Dean of the Law Department of the University of Michigan, has been elected President of the Iowa University.

DR. HENRY L. WHEELER, instructor in organic chemistry in the Sheffield Scientific School of Yale University, has been promoted to an assistant professorship.

AT Colorado College Dr. Florian Cajigas, formerly professor of physics, has been transferred to be head of the department of mathematics and Dr. S. J. Barnett has been promoted to professorship of physics.

MAJOR ROSS, known for his work on the malarial parasite, has been elected lecturer in the newly established School of Tropical Medicine at Edinburgh.

DR. OSKAR DOEBNER has been promoted to full professorship of chemistry and physics in the University of Halle. Dr. Kunz of Lausanne, has been appointed professor of physics in the veterinary school at D. Dr. Beck von Managetta, of the University of Vienna, has been made professor of botany at the University at Prague. Dr. Sommer and Dr. Cohen have qualified as docents in geology and physics respectively in the University at Göttingen. Professor Heinrich Ritthausen, professor of agricultural chemistry in the University at Königsberg, has retired.

SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; J. LE CONTE, Geology; W. M. DAVIS, Physiography; HENRY F. OSBORN, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; J. McKEEN CATTELL, Psychology; DANIEL G. BRINTON, J. W. POWELL, Anthropology.

FRIDAY, MAY 12, 1899.

CONTENTS:

<i>The Age of the Earth as an Abode fitted for Life:</i>	
LORD KELVIN.....	665
<i>The Posthum Phantom: A Study in the Spontaneous Activity of Shadows:</i>	
PRESIDENT DAVID STARR JORDAN.....	674
<i>Scientific Books:—</i>	
<i>Berry's History of Astronomy:</i>	PROFESSOR DAVID P. TODD.
<i>Rauh's De la methode dans la psychologie des sentiments:</i>	HIRAM M. STANLEY.
<i>Books Received.....</i>	682
<i>Societies and Academies:—</i>	
<i>American Mathematical Society:</i>	PROFESSOR F. N. COLE.
<i>Sub-section of Anthropology and Psychology of the New York Academy of Sciences:</i>	PROFESSOR CHARLES H. JUDD.
<i>Philosophical Society of Washington:</i>	E. D. PRESTON.....
	684
<i>Discussion and Correspondence:—</i>	
<i>Professor James on Telepathy:</i>	PROFESSOR E. B. TITCHENER.....
	686
<i>Notes on Physics:—</i>	
<i>The Compensation Pyrheliometer:</i>	A. ST. C. D....
	687
<i>Notes on Inorganic Chemistry:</i>	J. L. H.....
	688
<i>Botanical Notes:—</i>	
<i>Wood's Holl Botany; Canadian Botany; The Society for the Promotion of Agricultural Science:</i>	PROFESSOR CHARLES E. BESSEY
	689
<i>The Forests of Canada.....</i>	690
<i>An Exhibition of Geographical and Geological Material.....</i>	691
<i>Scientific Notes and News..</i>	692
<i>University and Educational News.....</i>	695

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

THE AGE OF THE EARTH AS AN ABODE FITTED FOR LIFE.*

§ 1. THE age of the earth as an abode fitted for life is certainly a subject which largely interests mankind in general. For geology it is of vital and fundamental importance—as important as the date of the battle of Hastings is for English history—yet it was very little thought of by geologists of thirty or forty years ago; how little is illustrated by a statement,† which I will now read, given originally from the presidential chair of the Geological Society by Professor Huxley in 1869, when for a second time, after a seven years' interval, he was President of the Society:

"I do not suppose that at the present day any geologist would be found * * * to deny that the rapidity of the rotation of the earth may be diminishing, that the sun may be waxing dim, or that the earth itself may be cooling. Most of us, I suspect, are Gallios, 'who care for none of these things,' being of opinion that, true or fictitious, they have made no practical difference to the earth, during the period of which a record is preserved in stratified deposits."

§ 2. I believe the explanation of how it was possible for Professor Huxley to say that he and other geologists did not care for things on which the age of life on the

* The annual address (1897) of the Victoria Institute, by Lord Kelvin, with additions written at different times from June, 1897, to May, 1898. Printed also in the *Philosophical Magazine*.

† In the printed quotations the italics are mine in every case, not so the capitals in the quotation from Page's Text-book.

earth essentially depends, is because he did not know that there was valid foundation for any estimates worth considering as to absolute magnitudes. If science did not allow us to give any estimate whatever as to whether 10,000,000 or 10,000,000,000 years is the age of this earth as an abode fitted for life, then I think Professor Huxley would have been perfectly right in saying that geologists should not trouble themselves about it, and biologists should go on in their own way, not inquiring into things utterly beyond the power of human understanding and scientific investigation. This would have left geology much in the same position as that in which English history would be if it were impossible to ascertain whether the battle of Hastings took place 800 years ago, or 800 thousand years ago, or 800 million years ago. If it were absolutely impossible to find out which of these periods is more probable than the other, then I agree we might be Gallios as to the date of the Norman Conquest. But a change took place just about the time to which I refer, and from then till now geologists have not considered the question of absolute dates in their science as outside the scope of their investigations.

§ 3. I may be allowed to read a few extracts to indicate how geological thought was expressed in respect to this subject, in various largely-used popular text-books, and in scientific writings which were new in 1868, or not so old as to be forgotten. I have several short extracts to read and I hope you will not find them tedious.

The first is three lines from Darwin's 'Origin of Species,' 1859 Edition, p. 287 :

"In all probability a far longer period than 300,000,000 years has elapsed since the latter part of the secondary period."

Here is another still more important sentence, which I read to you from the same book :

"He who can read Sir Charles Lyell's *Principles of Geology*, which the geologist will recognize as having produced a revolution in natural science, yet does not admit how *immensely vast* have been the past periods of *geological time*, at once close this volume."

I shall next read a short statement of Page's 'Advanced Students' Text of Geology,' published in 1859 :

"Again, where the FORCE seems unequal to the task, the student should never lose sight of the element TIME, an element to which we can set no limit in the past, any more than we know of its limit in the future."

"It will be seen from this hasty indication that there are two great schools of geological opinion, the one ascribing every result to the ordinary operations of Nature, combined with the element of *limited time*; the other appealing to agencies which operated during the earlier epochs of the world with greater intensity, and also for the most part over wider areas. *The former belief is certainly in accordance with the spirit of right philosophy*, and must be confessed that many problems seem to find their solution only through the adoption of the latter hypothesis."

§ 4. I have several other statements which I think you may hear with interest. Dr. Samuel Haughton, of Trinity College, Dublin, in his 'Manual of Geology,' published in 1865, p. 82, says :

"The infinite time of the geologists is in fact *and most of their speculations regarding this subject tend to imply the absolute infinity of time*, as if the imagination was unable to grasp the period requisite for the formation of a few inches of mud, and its subsequent consolidation into rock." (This delicate satire is certainly strained.)

"Professor Thomson has made an attempt to calculate the length of time during which the sun has been burning at the present rate, and come to the following conclusion : "It is probable that the whole, most probable that the sun has maintained the earth for 100,000,000 years, and is certain that he has not done so for 500,000,000 years. As for the future, we may say with equal certainty that the inhabitants of the earth cannot continue to enjoy the light and heat essential to their existence for many million years longer, unless new sources of energy are discovered."

unknown to us, are prepared in the great storehouse of creation."

I said that in the sixties and I repeat it now, but with charming logic it is held to be inconsistent with a later statement that the sun has not been shining 60,000,000 years, and that both that and this are stultified by a still closer estimate which says that probably the sun has not been shining for 30,000,000 years! And so my efforts to find some limit or estimate for Geological Time have been referred to and put before the public, even in London daily and weekly papers, to show how exceedingly wild are the wanderings of physicists, and how mutually contradictory are their conclusions, as to the length of time which has actually passed since the early geographical epochs to the present date.

Dr. Haughton further goes on :

"This result (100 to 500 million years) of Professor Thomson's, although very liberal in the allowance of time, has offended geologists, because, having been accustomed to deal with time as an infinite quantity at their disposal, they feel naturally embarrassment and alarm at any attempt of the science of physics to place a limit upon their speculations. It is quite possible that even a hundred million of years may be greatly in excess of the actual time during which the sun's heat has remained constant."

§ 5. Dr. Haughton admitted so much with a candid open mind, but he went on to express his own belief (in 1865) thus :

"Although I have spoken somewhat disrespectfully of the geological calculus in my lecture, yet I believe that the time during which organic life has existed on the earth is practically infinite, because it can be shown to be so great as to be inconceivable by beings of our limited intelligence."

Where is inconceivableness in 10,000,000,000? There is nothing inconceivable in the number of persons in this room or in London. We get up to millions quickly. Is there anything inconceivable in 30,000,000 as the population of England, or in 38,000,000 as the population of Great Britain and Ireland, or in 352,704,863 as the population of the British Empire? Not at all.

It is just as conceivable as half a million years or 500 millions.

§ 6. The following statement is from Professor Jukes's 'Students' Manual of Geology :

"The time required for such a slow process to effect such enormous results must, of course, be taken to be inconceivably great. The word 'inconceivably' is not here used in a vague but in a literal sense, to indicate that the lapse of time required for the denudation that has produced the present surfaces of some of the older rocks is vast beyond any idea of time which the human mind is capable of conceiving."

"Mr. Darwin, in his admirably reasoned book on the origin of species, so full of information and suggestion on all geological subjects, estimates the time required for denudation of the rocks of the Weald of Kent, or the erosion of space between the ranges of chalk hills, known as the North and South Downs, at three hundred millions of years. The grounds for forming this estimate are, of course, of the vaguest description. It may be possible, perhaps, that the estimate is a hundred times too great, and that the real time elapsed did not exceed three million years, but, on the other hand, it is just as likely that the time which actually elapsed since the first commencement of the erosion till it was nearly as complete as it now is was really a hundred times greater than his estimate, or thirty thousand millions of years."

§ 7. Thus Jukes allowed estimates of anything from 3 millions to 30,000 millions as the time which actually passed during the denudation of the Weald. On the other hand, Professor Phillips, in his Rede lecture to the University of Cambridge (1860), decidedly prefers one inch per annum to Darwin's one inch per century as the rate of erosion, and says that most observers would consider even the one inch per annum too small for all but the most invincible coasts! He thus, on purely geological grounds, reduces Darwin's estimate of the time to less than one one-hundredth. And, reckoning the actual thicknesses of all the known geological strata of the earth, he finds 96 million years as a possible estimate for the antiquity of the base of the stratified rocks; but he gives reasons for supposing that this may be an overestimate, and he

finds that from stratigraphical evidence alone we may regard the antiquity of life on the earth as possibly between 38 millions and 96 millions of years. Quite lately a very careful estimate of the antiquity of strata containing remains of life on the earth has been given by Professor Sollas, of Oxford, calculated according to stratigraphical principles which had been pointed out by Mr. Alfred Wallace. Here it is*: "So far as I can at present see, the lapse of time since the beginning of the Cambrian system is probably less than 17,000,000 years, even when computed on an assumption of uniformity, which to me seems contradicted by the most salient facts of geology. Whatever additional time the calculations made on physical data can afford us may go to the account of pre-Cambrian deposits, of which at present we know too little to serve for an independent estimate."

§ 8. In one of the evening *Conversazioni* of the British Association during its meeting at Dundee in 1867 I had a conversation on geological time with the late Sir Andrew Ramsay, almost every word of which remains stamped on my mind to this day. We had been hearing a brilliant and suggestive lecture by Professor (now Sir Archibald) Geikie on the geological history of the actions by which the existing scenery of Scotland was produced. I asked Ramsay how long a time he allowed for that history. He answered that he could suggest no limit to it. I said, "You don't suppose things have been going on always as they are now? You don't suppose geological history has run through 1,000,000,000 years?" "Certainly I do." "10,000,000,000 years?" "Yes." "The sun is a finite body. You can tell how many tons it is. Do you think it has been shining on for a million million years?" "I am as incapable of estimating and understanding the reasons which you physicists have for limiting geological time

* 'The Age of the Earth,' *Nature*, April 4, 1895.

as you are incapable of understanding geological reasons for our unlimited mates." I answered, "You can understand physicists' reasoning perfectly if you put your mind to it." I ventured also that physicists were not wholly incapable of appreciating geological difficulties so the matter ended, and we had a formal agreement to temporarily differ.

§ 9. In fact, from about the beginning of the century till that time (1867), geology had been nurtured in a philosophy originating with the Huttonian system: of it substantially very good philosophy, but some of it essentially unsound and misleading; witness this, from Playfair, the eloquent and able expounder of Hutton

"How often these vicissitudes of decay and extension have been repeated is not for us to determine; they constitute a series of which as the author of the theory has remarked, we neither see the beginning nor the end; a circumstance that accords well with what is known concerning other parts of the history of the world. In the continuation of the development of the species of animals and vegetables that inhabit the earth, we discern neither a beginning nor an end; the planetary motions where geometry has the eye so far both into the future and the past discover no mark either of the commencement or termination of the present order."

§ 10. Led by Hutton and Playfair, who taught the doctrine of eternity and uniformity in geology; and to explain planetary action and underground heat, invented thermo-electric 'perpetual' motion, which, in the year 1862, in my paper on the 'Secular Cooling of the Earth,'* published in the 'Transactions of the Royal Society of Edinburgh,' I commented as follows:

"To suppose, as Lyell, adopting the chemical hypothesis, has done,† that the substances, combined together, may be again separated electrolytically by thermo-electric currents, due to the heat generated by their combination, and thus the chemical action

* Reprinted in Thomson and Tait 'Treatise on Natural Philosophy,' 1st and 2d Editions, Appendix D (g).

† 'Principles of Geology,' Chap. XXXI., ed.

its heat continued in an endless cycle, violates the principles of natural philosophy in exactly the same manner, and to the same degree, as to believe that a clock constructed with a self-winding movement may fulfil the expectations of its ingenious inventor by going forever."

It was only by sheer force of reason that geologists have been compelled to think otherwise, and to see that there was a definite beginning, and to look forward to a definite end of this world as an abode fitted for life.

§ 11. It is curious that English philosophers and writers should not have noticed how Newton treated the astronomical problem. Playfair, in what I have read to you, speaks of the planetary system as being absolutely eternal, and unchangeable; having had no beginning and showing no signs of progress towards an end. He assumes also that the sun is to go on shining forever and that the earth is to go on revolving round it forever. He quite overlooked Laplace's nebular theory; and he overlooked Newton's counterblast to the planetary 'perpetual motion.' Newton, commenting on his own 'First Law of Motion,' says, in his terse Latin, which I will endeavor to translate, "But the greater bodies of planets and comets moving in spaces less resisting keep their motions longer." That is a strong counterblast against any idea of eternity in the planetary system.

§ 12. I shall now, without further preface, explain, and I hope briefly, so as not to wear out your patience, some of the arguments that I brought forward between 1862 and 1869, to show strict limitations to the possible age of the earth as an abode fitted for life.

Kant* pointed out in the middle of last

* In an essay first published in the *Königsberg Nachrichten*, 1754, Nos. 23, 24; having been written with reference to the offer of a prize by the Berlin Academy of Sciences in 1754. Here is the title page in full as it appears in Vol. VI. of Kant's *Collected Works*, Leipzig, 1839: *Untersuchung der Frage:*

century what had not previously been discovered by mathematicians or physical astronomers, that the frictional resistance against tidal currents on the earth's surface must cause a diminution of the earth's rotational speed. This really great discovery in natural philosophy seems to have attracted very little attention—indeed to have passed quite unnoticed—among mathematicians and astronomers and naturalists, until about 1840, when the doctrine of energy began to be taken to heart. In 1866, Delaunay suggested that tidal retardation of the earth's rotation was probably the cause of an outstanding acceleration of the moon's mean motion reckoned according to the earth's rotation as a time-keeper found by Adams in 1853 by correcting a calculation of Laplace which had seemed to prove the earth's rotational speed to be uniform.* Adopting Delaunay's suggestion as true, Adams, in conjunction with Professor Tait and myself, estimated the diminution of the earth's rotational speed to be such that the earth as a time-keeper, in the course of a century, would get 22 seconds behind a thoroughly perfect watch or clock rated to agree with it at the beginning of the century. According to this rate of retardation the earth, 7,200 million years ago, would have been rotating twice as fast as now; and the centrifugal force in the equatorial regions would have

Ob die Erde in ihrer Umdrehung um die Achse, wodurch sie die Abwechselung des Tages und der Nacht hervorbringt, einige Veränderung seit den ersten Zeiten ihres Ursprunges erlitten habe, welches die Ursache davon sei, und woraus man sich ihrer versichern könne? welche von der Königlichen Akademie der Wissenschaften zu Berlin zum Preise aufgegeben worden, 1754.

* 'Treatise on Natural Philosophy' (Thomson and Tait), § 830, ed. 1, 1867, and later editions; also 'Popular Lectures and Addresses,' Vol. II. (Kelvin), 'Geological Time,' being a reprint of an article communicated to the Glasgow Geological Society, February 27, 1868.

been four times as great as its present amount, which is $\frac{1}{288}$ of gravity. At present the radius of the equatorial sea-level exceeds the polar semi-diameter by $21\frac{1}{2}$ kilometers, which is, as nearly as the most careful calculations in the theory of the earth's figure can tell us, just what the excess of equatorial radius of the surface of the sea all round would be if the whole material of the earth were at present liquid and in equilibrium under the influence of gravity and centrifugal force with the present rotational speed, and $\frac{1}{4}$ of what it would be if the rotational speed were twice as great. Hence, if the rotational speed had been twice as great as its present amount when consolidation from approximately the figure of fluid equilibrium took place, and if the solid earth, remaining absolutely rigid, had been gradually slowed down in the course of millions of years to its present speed of rotation, the water would have settled into two circular oceans round the two poles; and the equator, dry all round, would be 64.5 kilometers above the level of the polar sea bottoms. This is on the supposition of absolute rigidity of the earth after primitive consolidation. There would, in reality, have been some degree of yielding to the gravitational tendency to level the great gentle slope up from each pole to equator. But if the earth, at the time of primitive consolidation, had been rotating twice as fast as at present, or even 20 per cent. faster than at present, traces of its present figure must have been left in a great preponderance of land, and probably no sea at all, in the equatorial regions. Taking into account all uncertainties, whether in respect to Adams' estimate of the rate of frictional retardation of the earth's rotatory speed, or to the conditions as to the rigidity of the earth once consolidated, we may safely conclude that the earth was certainly not solid 5,000 million years ago, and

was probably not solid 1,000 million ago.*

§ 13. A second argument for limiting the earth's age, which was really my first argument, is founded on the condition of underground heat. To express a first rough and ready estimate of it, I read one short statement. It is from a short paper that I communicated to the Royal Society of Edinburgh on the 12th December, 1865, entitled, 'The Doctrine of Uniformity in Geology Briefly Refuted.'

"The 'Doctrine of Uniformity' in Geology, held by many of the most eminent of British geologists, assumes that the earth's surface and crust have been nearly as they are at present temperature, and other physical qualities, during the whole of the millions of years. But *the heat which we know to be now conducted out of the earth* is so great, that if this action had been going on since any approach to uniformity for 20,000 million years, the amount of heat lost out of the earth would have been about as much as would heat, by 100° Fahrenheit, a quantity of ordinary surface rock of 100 times the bulk of the earth's bulk. This would be more than enough to melt a mass of surface rock equal in bulk to the whole earth. No hypothesis as to chemical composition, or internal fluidity, effects of pressure at great depths, or possible character of substances in the interior of the earth, possessing the smallest vestige of probability, can justify the supposition that the earth's crust has remained nearly as it is, while for the whole, or from any part, of the earth, so great a quantity of heat has been lost."

§ 14. The sixteen words which I have emphasized in reading this statement (italics in the reprint) indicate the method of fact foundation for the conclusion asserted. This conclusion suffices to sweep away the whole system of geological and biological speculation demanding an

* The fact that the continents are arranged along meridians rather than in an equatorial belt is some degree of proof that the consolidation of the earth took place at a time when the diurnal rotation differed but little from its present value. It is probable that the date of consolidation is considerably more recent than a thousand million years ago. Thomson and Tait, 'Treatise on Natural Philosophy' 2d ed., 1883, § 830.

conceivably' great vista of past time, or even a few thousand million years, for the history of life on the earth, and approximate uniformity of plutonic action throughout that time; which, as we have seen, was very generally prevalent thirty years ago, among British Geologists and Biologists; and which, I must say, some of our chiefs of the present day have not yet abandoned. Witness the Presidents of the Geological and Zoological Sections of the British Association at its meetings of 1893 (Nottingham), and of 1896 (Liverpool):

Mr. Teall: Presidential Address to the Geological Section, 1893, "The good old British ship 'Uniformity,' built by Hutton and refitted by Lyell, has won so many glorious victories in the past, and appears still to be in such excellent fighting trim, that I see no reason why she should haul down her colors either to 'Catastrophe' or 'Evolution.' Instead, therefore, of acceding to the request to 'hurry up' we make a demand for more time."

Professor Poulton: Presidential Address to the Zoological Section, 1896. "Our argument does not deal with the time required for the origin of life, or for the development of the lowest beings with which we are acquainted from the first formed beings, of which we know nothing. Both these processes may have required an immensity of time; but as we know nothing whatever about them and have as yet no prospect of acquiring any information, we are compelled to confine ourselves to as much of the process of evolution as we can infer from the structure of living and fossil forms—that is, as regards animals, to the development of the simplest into the most complex Protozoa, the evolution of the Metazoa from the Protozoa, and the branching of the former into its numerous Phyla, with all their Classes, Orders, Families, Genera, and Species. But we shall find that this is quite enough to necessitate a very large increase in the time estimated by the geologist."

§ 15. In my own short paper from which I have read you a sentence, the rate at which heat is at the present time lost from the earth by conduction outwards through the upper crust, as proved by observations of underground temperature in different parts of the world, and by measurement of the thermal conductivity of surface rocks and strata, sufficed to utterly refute the

Doctrine of Uniformity as taught by Hutton, Lyell, and their followers; which was the sole object of that paper.

§ 16. In an earlier communication to the Royal Society of Edinburgh,* I had considered the cooling of the earth due to this loss of heat; and by tracing backwards the process of cooling had formed a definite estimate of the greatest and least number of million years which can possibly have passed since the surface of the earth was everywhere red hot. I expressed my conclusion in the following statement: †

"We are very ignorant as to the effects of high temperatures in altering the conductivities and specific heats and melting temperatures of rocks, and as to their latent heat of fusion. We must, therefore, allow very wide limits in such an estimate as I have attempted to make; but I think we may with much probability say that the consolidation cannot have taken place less than 20 million years ago, or we should now have more underground heat than we actually have; nor more than 400 million years ago, or we should now have less underground heat than we actually have. That is to say, I conclude that Leibnitz's epoch of emergence of the *consensientior status* [the consolidation of the earth from red hot or white hot molten matter] was probably between those dates."

§ 17. During the 35 years which have passed since I gave this wide-ranged estimate, experimental investigation has supplied much of the knowledge then wanting regarding the thermal properties of rocks to form a closer estimate of the time which has passed since the consolidation of the earth, and we have now good reason for judging that it was more than 20 and less than 40 million years ago; and probably much nearer 20 than 40.

§ 18. Twelve years ago, in a laboratory established by Mr. Clarence King, in con-

* 'On the Secular Cooling of the Earth,' Trans. Roy. Soc. Edinburgh, Vol. XXIII., April 28, 1862, reprinted in Thomson and Tait, Vol. III., pp. 468-485, and Math. and Phys. Papers, art. XCIV., pp. 295-311.

† 'On the Secular Cooling of the Earth,' Math. and Phys. Papers, Vol. III., § 11 of art. XCIV.

nection with the United States Geological Survey, a very important series of experimental researches on the physical properties of rocks at high temperatures was commenced by Dr. Carl Barus, for the purpose of supplying trustworthy data for geological theory. Mr. Clarence King, in an article published in the *American Journal of Science*,* used data thus supplied, to estimate the age of the earth more definitely than was possible for me to do in 1862, with the very meagre information then available as to the specific heats, thermal conductivities, and temperatures of fusion of rocks. I had taken 7000° F. (3781° C.) as a high estimate of the temperature of melting rock. Even then I might have taken something between 1000° C. and 2000° C. as more probable, but I was most anxious not to *underestimate* the age of the earth, and so I founded my primary calculation on the 7000° F. for the temperature of melting rock. We know now from the experiments of Carl Barus† that diabase, a typical basalt of very primitive character, melts between 1100° C. and 1170°, and is thoroughly liquid at 1200°. The correction from 3871° C. to 1200° or $1/3.22$ of that value, for the temperature of solidification, would, with no other change of assumptions, reduce my estimate of 100 millions to $1/(3.22)^3$ of its amount, or a little less than 10 million years; but the effect of pressure on the temperature of solidification must also be taken into account, and Mr. Clarence King, after a careful scrutiny of all the data given him for this purpose by Dr. Barus, concludes that without further experimental data 'we have no warrant for extending the earth's age beyond 24 millions of years.'

§ 19. By an elaborate piece of mathe-

* 'On the Age of the Earth,' Vol. XLV., January, 1893.

† *Phil. Mag.* 1893, first half-year, pp. 186, 187, 301-305.

matical bookkeeping, I have worked the problem of the conduction of heat downwards from the earth, with specific heat increasing up to the melting point as by Rücker and Roberts-Austen as Barus, but with the conductivity as constant; and, by taking into account augmentation of melting temperature with pressure in a somewhat more convenient manner than that adopted by Mr. Clarence King, I am not led to differ much from his estimate of 24 million years. But, we know something more than we knew at present as to the probable diminution of thermal conductivity with increasing temperature, which would shorten the time since consolidation, it would be quite advisable to publish any closer estimate.

§ 20. All these reckonings of the heat of underground heat, the details of which I am sure you do not wish me to put before you at present, are founded on the simple assumption that the material of the present solid earth all round its surface at one time a white-hot liquid. The earth is at present losing heat from its surface all round from year to year and century to century. We may dismiss as utterly untenable any supposition such as that of a thousand or a few million years of the present régime in this respect was preceded by a few thousand or a few million years of heating from without. History, guided by science, is bound to find, if possible, an antecedent condition preceding every known state of affairs, whether of dead matter or of living creatures. Unless the earth was created solid and hot out of nothing, the régime of continued loss of heat must have been preceded by molten matter all round the surface.

§ 21. I have given strong reasons for believing that *immediately* before solidification at the surface, the interior was a

* On the Secular Cooling of the Earth, Vol. I. Math. and Phys. Papers, §§ 19-33.

close up to the surface; except comparatively small portions of lava or melted rock among the solid masses of denser solid rock which had sunk through the liquid, and possibly a somewhat larger space around the center occupied by platinum, gold, silver, lead, copper, iron and other dense metals, still remaining liquid under very high pressure.

§ 22. I wish now to speak to you of depths below the great surface of liquid lava bounding the earth before consolidation; and of mountain heights and ocean depths formed probably a few years after a first emergence of solid rock from the liquid surface (see § 24, below) which must have been quickly followed by a complete consolidation all around the globe. But I must first ask you to excuse my giving you all my depths, heights and distances, in terms of the kilometer, being about six-tenths of that very inconvenient measure the English statute mile, which, with all the other monstrosities of our British metrical system, will, let us hope, not long survive the legislation of our present Parliamentary session destined to honor the sixty years' Jubilee of Queen Victoria's reign by legalizing, the French metrical system for the United Kingdom.

§ 23. To prepare for considering consolidation at the surface let us go back to a time (probably not more than twenty years earlier as we shall presently see—§ 24) when the solid nucleus was covered with liquid lava to a depth of several kilometers; to fix our ideas let us say 40 kilometers (or 4 million centimeters). At this depth in lava, if of specific gravity 2.5, the hydrostatic pressure is 10 tons weight (10 million grammes) per square centimeter, or ten thousand atmospheres approximately. According to the laboratory experiments of Clarence King and Carl Barus* on Diabase,

* *Philosophical Magazine*, 1893, first half-year, p. 306.

and the thermodynamic theory* of my brother, the late Professor James Thomson, the melting temperature of diabase is 1170° C. at ordinary atmospheric pressure, and would be 1420° under the pressure of ten thousand atmospheres, if the rise of temperature with pressure followed the law of simple proportion up to so high a pressure.

§ 24. The temperature of our 40 kilometers deep lava ocean of melted diabase may therefore be taken as but little less than 1420° from surface to bottom. Its surface would radiate heat out into space at some such rate as two (gramme-water) thermal units Centigrade per square centimeter per second.† Thus, in a year (31½ million seconds) 63 million thermal units would be lost per square centimeter from the surface. This is, according to Carl Barus, very nearly equal to the latent heat of fusion abandoned by a million cubic centimeters of melted diabase in solidifying into the glassy condition (pitch-stone) which is assumed when the freezing takes place in the course of a few minutes. But, as found by Sir James Hall in his Edinburgh experiments‡ of 100 years ago, when more than a few minutes is taken for the freezing, the solid formed is not a glass but a heterogeneous crystalline solid of rough fracture; and if a few hours or days, or any longer time, is taken, the solid formed has the well-known rough crystalline structure of basaltic rocks found in all parts of the world. Now Carl Barus finds that basaltic

* *Trans. Roy. Soc., Edinburgh*, Jan. 2, 1849; Cambridge and Dublin *Mathematical Journal*, Nov., 1850. Reprinted in *Math. and Phys. Papers (Kelvin)*, Vol. I., p. 156.

† This is a very rough estimate which I have formed from consideration of J. T. Bottomley's accurate determinations in absolute measure of thermal radiation at temperatures up to 920° C. from platinum wire and from polished and blackened surfaces of various kinds in receivers of air-pumps exhausted down to one ten-millionth of the atmospheric pressure. *Phil. Trans. Roy. Soc.*, 1887 and 1893.

‡ *Trans. Roy. Soc. Edinburgh*.

diabase is 14 per cent. denser than melted diabase, and 10 per cent. denser than the glass produced by quick freezing of the liquid. He gives no data, nor do Rücker and Roberts-Austen, who have also experimented on the thermodynamic properties of melted basalt, give any data, as to the latent heat evolved in the consolidation of liquid lava into rock of basaltic quality. Guessing it as three times the latent heat of fusion of the diabase pitch-stone, I estimate a million cubic centimeters of liquid frozen per square centimeter per centimeter per three years. This would diminish the depth of the liquid at the rate of a million centimeters per three years, or 40 kilometers in twelve years.

§ 25. Let us now consider in what manner this diminution of depth of the lava ocean must have proceeded, by the freezing of portions of it; all having been at temperatures very little below the assumed 1420° melting temperature of the bottom, when the depth was 40 kilometers. The loss of heat from the white-hot surface (temperatures from 1420° to perhaps 1380° in different parts) at our assumed rate of two (gramme-water Centigrade) thermal units per sq. cm. per sec. produces very rapid cooling of the liquid within a few centimeters of the surface (thermal capacity .36 per gramme, according to Barus) and in consequence great downward rushes of this cooled liquid, and upwards of hot liquid, spreading out horizontally in all directions when it reaches the surface. When the sinking liquid gets within perhaps 20 or 10 or 5 kilometers of the bottom, its temperature* becomes the freezing-point as raised by the increased pressure; or, perhaps more correctly stated, a temperature at which some of its ingre-

dients crystallized out of it. Hence, being a few kilometers above the bottom we have a snow shower of solidified lava of crystalline flakes, or prisms, or grains of feldspar, mica, hornblende, quartz and other ingredients: each little crystalline mass and falling somewhat faster than the descending liquid around it till it reaches the bottom. This process goes on until the heaping of granules and crystals at the bottom, our lava ocean becomes silted and the surface.

(To be concluded.)

THE POSTHUMOUS PHANTOM: A STUDY IN SPONTANEOUS ACTIVITY OF SHADOWS

At the April meeting of the Astral Club of Alcalde the veteran sciosophic former President of the Stanislaus Geological Society, Mr. Abner Dean of Alameda, described his investigations of shadows as exemplified in the strange case of Schlemihl.

It seems that this gentleman, late agent of Kunersdorf, in Germany, on one occasion was approached by a gray-haired stranger who offered to purchase his shadow. Schlemihl named a price, which was instantly accepted. Thereupon the stranger knelt upon the grass, rolled up the shadow, folded it neatly and thrust it into his sack, at once disappearing down the alley between two hedges of roses, leaving Schlemihl himself absolutely shadowless.

At first the poor man took the deprivation lightly. But, as time went on, the singularity of his position wore upon him, the whispered words and doubtful glances of his friends began to distress him, he fell into a condition of marked physical discomfort. He set out in search

* The temperature of the sinking liquid rock rises in virtue of the increasing pressure: but much less than does the freezing point of the liquid or of some of its ingredients. (See Kelvin, Math. and Phys. Papers, Vol. III., pp. 69, 70.)

* 'Posthumous Humanity: A study of Phantoms' by Adolph D'Assier, Member of the Bordeaux Academy of Sciences. Translated and Annotated by H. S. Olcott; London, George Redway, York St., Covent Garden.

the shadow and, after many adventures, he overtook the man to whom he had sold it. But neither promises nor blows availed anything. The stranger turned a deaf ear to the former, and the latter only served to tear or bruise the shadow which the stranger used in self-defence. When at last Schlemihl died it was observed he left no wraith to rustle through the old graveyard at Kunersdorf. According to Mr. Chamisso, a friend of Schlemihl, who has recorded the facts above noted, "An event had taken the place of an action as has happened not infrequently in the world's history." That he was unable to nullify this event was supposed to be the cause of the failure of his efforts at self-realization. But this ethereal epigram does not explain why the loss of his shadow made him physically uncomfortable. For the cause of this we must search in the fluidic conditions by which he was surrounded.

Mr. Dean has, therefore, devoted special attention to these details, to make clear the nature of the shadow itself and of the being who made way with it.

Certain writers have too hastily assumed that this being was the Devil. This is obviously not the case, for this fabled creation, the 'Faded fancy of an elder world,' 'the fluidic phantom of effete orthodoxy,' as Mr. Dean styled it, has no objective existence. The fact that the stranger was dressed in black which seemed red by transmitted light, and that he exhaled a faint sulphurous aroma, would seem to bear out this supposition. But these details were more likely results of pure fancy, perhaps heightened by the presence of a highly concentrated fluidic aura.

The real nature of the being is shown by the erudite researches of Dr. Adolph D'Assier on the 'fauna of the shades,' as set forth in his remarkable volume on 'Posthumous Humanity.' The stranger was, doubtless, a lycanthropic posthom, or

shadow-devouring phantom, who, being unable to suck the blood of Schlemihl himself, carried away his shadow to strengthen his own fast waning identity. There are many records, especially among the peasants of Little Russia, of phantoms who satisfy their hunger in this uncanny way. The word lycanthropic (wolf-manly) was drawn from this common habit with the wehr-wolf, the phantasmal double of the common gray wolf. The same tendencies are found in posthoms of wolf-like men to which the generic term 'lycanthropic' is also applied. It may be noted that now the wolf is practically extinct in the forests of Germany; its posthom, the wehr-wolf, no longer appears and its familiar call of 'willi-wa-wu: wito-hu' is no longer heard in the German shades.

The name posthom (*post*—after; *homo*—man) was some years since offered by Mr. Dean as a general designation for those phantasmal doubles which D'Assier calls by the awkward and inadequate name of fluidic forms or fluidic phantoms. It was at first supposed that these creations were exclusively human and natural sequences of physical death. The error of this opinion is now made evident, but the convenient name, as more definite than phantom and more generic than wraith, may still be retained with this broader definition.

The origin of the posthom is thus explained by Mr. Dean: It is well known that all animals and plants are built up of cells or chambers, each cell containing the magnetic life jelly or protoplasm. It is also well established that these cells are not completely filled by this substance. Moreover, it is known that even protoplasm itself is not a true liquid, but a mass of network, like a skein of tangled yarn. In this cell and its skein of protoplasm the minute atoms of the odic forces of the universe penetrate. In so doing, by their entanglement and permeation, they built up within the cells a form corresponding in all re-

spects to that of the living creature as a whole, but in reality its double or negative, being solid only when the first is empty, and being empty when the first is solid.

The well-known astral body of man is a species of posthom. But astrality is not confined to man. It has been shown by Mr. William Q. Judge that the 'body of the jelly-fish is almost pure astral substance.' It is, in fact, a posthom of a marine organism which has become saturated with water, which fills all the interstices in its anatomy, thus giving it an independent and self-perpetuating existence. For the distinguished scientist of the Society of Bordeaux has shown that the posthom phantom of man is "the exact image of the person of whom it is the complement. Internally it represents the mould of all the organs which constitute the framework of the human body. We see it, in short, move, speak, take nourishment, perform, in a word, all the great functions of animal life. The extreme tenuity of these constituent molecules, which represent the last term of organic matter, allow it to pass through the walls and partitions of apartments. Nevertheless, as it is united with the body, from which it emanates by an invisible vascular plexus, it can, at will, draw to itself, by a sort of aspiration, the greater part of the living forces which animate the latter. One sees, then, by a singular inversion, life withdrawn from the body, which then exhibits a cadaverous rigidity and transfers itself entirely to the phantom, which acquires consistency, sometimes even to the point of struggling with persons before whom it materializes. It is but exceptionally that it shows itself in connection with a living person." But as soon as death has snapped the bonds (or vascular plexus) that attach it to our organism it definitely separates itself from the human body and constitutes the 'posthumous phantom' or posthom.

The fact of the occasional separation of the posthom during life is now positively authenticated. The case of Schlemih under this head, as also the remarkable experience related by Mr. H. C. Andersen of Copenhagen. A Danish country man, of good family, it is alleged, lost his shadow at one time. He took a humorous view of the accident at first and comforted himself with the reflection that the shadow had set too much store on shadows and shadows. But as time went on his philosophy changed. He noted that his own strength oozed away and later that his clothing was becoming brittle and unable to support the strain. It, too, had lost its shadow. His friends brought him word of strange things which his double performed in the streets of the neighborhood, although at the time he was confined to his room and unable to get to his bed. Apparently the posthomous phantom felt a strange delight in bringing his master into ridicule. Finally it had usurped his place in social functions, and with a high hand and giving him no opportunity to be heard in his own defence. At last, in violent indignation, by a supreme effort of the will, the gentleman recalled his phantom, to the endless mystification of his friends. With the return of the posthom to his own cellular substance his physical and mental vigor returned and his new shadow of clothes showed no lack of the ordinary shadow.

It will be noticed that in this case the phantom man was clothed in phantom clothing. This was similarly formed, being composed of the tenuous molecules which fill the cloth cells of the original garments. It is notorious that posthoms are clothed in materials similar to those worn by the person from whom they are derived, this serves as a moment's explanation.

Dr. D'Assier has conclusively shown that even inanimate bodies have their double or posthoms, as well as men and be-

This was at first doubted by that most critical of scientists, Mr. Henry S. Olcott, of Madras. He was, however, convinced of its correctness by the well-authenticated fact that inanimate bodies, as rocks and teacups, equally with animate bodies, are able to cast shadows. From the shadows of teacups philosophical generalizations of great value have been obtained in India and Thibet. The only body known to man which has no fluidic double, or shadow, is the sun. Its phantom is, perhaps, the whole visible universe, and it is the undoubted center of that fluidic force which is expulsive of all shadows. The shadow of an object is not as most people suppose, merely the absence of sunshine. If that were all it would be much less substantial in its nature than is now the case and would have no definite boundaries. The shadow is the phantasmal double. All material bodies have interspaces among their atoms corresponding to the cells in living organisms. Indeed, it is well known that molecules of matter nowhere touch one another, nor do they come anywhere near touching. If we could conceive the physical molecules of a rock as inhabited worlds a being with a telescope on one of them would gaze at his neighbor atom as our astronomers gaze forth on the mighty sun of Sirius. It is also well known that molecules do not really exist at all, but that each is really an eddy or storm center, and thus a center of attraction in the fluidic atmosphere of astral substances, in which all inhabited worlds are bathed. But omitting these considerations, which belong to ultimate science, or sciosophy, there is no doubt that the shadow of a man or a rock is itself an objective reality. It is a posthum driven out from its original station by the expellatory force of the sun. "The huge conical shadow of the earth which reaches beyond the moon and is called night" is not merely the absence of light. It is the hour of posthum

phantoms when all nature is saturated in fluidic forces. It is natural, then, that at night phantasms of all degrees should be at large, and that in this period and under its conditions all successful studies in the natural history of the shades have been accomplished.

During life the carnate body exerts a strong attraction for its posthum, so that the shadow is seldom seen far away from its host. Toward evening, however, it wanders more widely, and at last it may be apparently wholly detached. Whether this is really ever the case under normal conditions is not yet certainly known. This question will be the subject of further investigations by the members of the club at Alcalde.

Mr. James M. Barrie, of Edinburgh, in a volume bearing the curious title of 'Sentimental Tommy,' tells us that once in his youth he turned a corner in running so suddenly that he thereby 'dislocated his shadow.' It is easy to see that this might occur, though probably infrequently.

It is certain that at death the host ceases to exert any particular hold over its phantasm. The shadow wanders freely and at will. It is soon disconcerted because the stars begin to devour its substance, and it is but rarely that means can be found to resist their malign influence. For this reason all phantoms of the dead are disintegrated and reduced to primæval vapor within a space of ten to twenty days after their disassociation. This fear of dissolution is the cause of the violent excitement often shown by phantoms. From the same cause arises their proneness to linger about the haunts of the host in life or about his place of burial.

Certain classes of posthum phantoms have been known to suck the blood of the living, and thus to maintain a precarious existence for a number of days or weeks. These are known as vampires, and their existence

may usually be recognized by the roseate appearance of the body from which they are derived. It is said that the reduction of this body to ashes by fire will destroy the vampire posthum. At least Mr. Dean is convinced, from the experiences of several peasants in Lithuania, that this is correct. In all events, it is reasonable to suppose that the heat of a funeral pyre would attract the disintegrating posthum, and, once drawn into the current of hot air, it could in no way save itself.

"The most common yearning of the posthumous being," says Dr. D'Assier, "is to bid the last farewell to those who are used to it." But experiments prove that it is equally accessible to ideas of vengeance, while the wraiths of those who are unhappy in their affections are somewhat extremely perverse and demonstrative, being 'not always satisfied to signify resentment by noisy but harmless manifestations.'

While a vast array of cases are cited in support of the theory that posthoms delight in sympathy and in vengeance, one must be very cautious in receiving such evidence. We must not read our own emotions into the vagrant actions of the poor disconsolate shadows. The impending dissolution of posthum stares it, as it were, every moment in the face, and it may follow friend or enemy in the sole hope of somehow drawing substance, either blood or shadow, in order to continue its existence. They cannot last long at the best, nor is it right that they should do so, for if their status were indefinitely prolonged, as some have maintained, the world would long ago have become solidly full of phantoms, and for the amount of fluidic ether necessary for their production we should be obliged to draw on some other universe.

Dr. D'Assier very wisely observes (p. 176, *Posthumous Humanity*): "The perennial survival of shades would long ago have rendered this planet uninhabitable to us.

The dead would occupy the place living, for the accumulation of species the different tribes of the terrestrial heaped at the surface of the globe since first geological epochs would render air irrespirable. We could not move in a dense atmosphere of ghosts. chemical analysis has never shown in air the presence of either of the imm principles which enter into the constitution of a fluidic phantasmal form elaborated by an animal economy. For our part, we have a bitter regret that these venerable shades have disappeared."

The evidence, on the other hand, is ever, worth consideration, as is shown by the following experiments of the famous Allan Kardec. One day his fancy led him to evoke the posthum of Tartuffe.

"Tartuffe did not wait to be dragged by the ears, but speedily showed himself all his classical peculiarities! It was manifestly the personage created by Molière, his soft and hypocritical speech, his wily ways, his air of sugar-coated hypocrisy. When, after close examination, he was satisfied as to the phantom's identity he was transported with pleasure and said to me:

"By the way, how is it that you are here, seeing that you never had any existence?"

"That is true," answered the spirit in a most contrite tone, 'I am the spirit of an actor who used to play the part of Tartuffe.' Tartuffe, being unable to find himself for a very good reason, sends for an actor in his place."

Kardec again tells of a nest of little birds in a garden. The nest having disappeared, the gentleman became uneasy as to the fate of his little pets. Being a person of enormous animal magnetism and, therefore, adept in the calling and training of posthums, he went through the usual ceremony of calling the phantom of the mother bird, and, finding it was seeking caterpillars in a neighbor-

tree. The shadow of the bird immediately came to him and replied to the anxious questioner: "Be quite easy. My young ones are safe and sound. The house-cat knocked down the nest in jumping on the garden wall. You will find them in the grass at the foot of the wall." The gentleman hurried to the garden and found the little nestlings full of life at the spot indicated.

As both these stories are perfectly authenticated, we must consider them in the light of our phantom knowledge. As the birds themselves were living at the time, the projection of their shadow offers nothing incongruous, especially if it took place in the dusk of the evening, a detail which Mr. Kardec omits, but which we may readily supply. The natural anxiety of the mother bird would, as it were, lend the shadow wings, and her intensity of feeling would produce the effect of conversation. It is not likely that the bird actually spoke, for the incident took place in France, and no bird, not even the most refined parrot, has yet spoken French. There are other ways of conveying information than word of mouth, and an enlightened master knows how to make use of them. In the case of *Tartuffe* the phantom may have been real and virtually immortal. It belongs to another class than the shadow phantoms. The creation of a great poet's brain has an objective existence which may be far more permanent than the shadow of an ordinary actor. No doubt, the image formed in the brain having the gigantic aura of that of Molière could so embody itself in astral precipitates as to secure a life which might endure for centuries.

It need surprise no one to meet the phantasm of *Tartuffe* in real existence. Surely the shades of Hamlet and Portia and Othello have a definite place among the objective phenomena of Earth just as surely as their names have a fixed place in our

literature. Doubtless, at times this posthumous Shylock crosses the Rialto bridge, and the phantom of melancholy Jacques may be found flitting disconsolate through the forest of Arden. The sad plight of the posthumous King of Denmark, for example, has not failed to touch the hearts of all lovers of literature. Indeed, the strength of the genius of Shakespeare is such that the ancient king and his famous son and namesake have as firm a reality as that of the mediocre flesh and blood people which swarm in modern society. We may notice in passing that the speech of the phantom king indicates that he was plunged in the depths of sorrow. "The impression left on the mind," says D'Assier, "by the lamentations and the vain replies of the shades who succeed in making themselves heard is always a sentiment of profound sadness." He compares the feelings of such a personage to those of a European transported suddenly and nakedly into the wilds of Australia, with just enough of his reason left "to have the feeling of his impotence and eternal isolation."

Dr. Eliphas Levi, in his famous 'Dogma and Ritual,' traces the career of shades still more closely, emphasizing especially the existence of two mortal bodies after death, the one heavy and confined on the earth, the other flitting about in the mediate atmosphere. "When a man has lived well," says Dr. Levi, the astral corpse or posthumous "evaporates like a fine incense in mounting to higher regions. If the subject lived in crime this phantom retained as prisoner seeks the object of its passions and tries still to cling to life. But the stars breathe it and drink it ('les astres l'aspirent et le boivent'). It feels its intelligence grow feeble. Its memory is slowly lost; all its being must dissolve."

Those scientific men (and there are many) who find all attributes of the universe derived from the four gases, hydrogen

(blue or spirit), phosphorus (red or hope), carbon (black or fear) and nitrogen (green or life), derive from their postulates a different view of the nature of shades and phantoms. In the famous treatise on the 'Discovery of Misconceptions' this theory is set forth in an engaging manner.

"The ethnological divisions of the human race," says the author, "proceed directly from excessive vibrations of these four gases. The white skin of the Caucasian marks an approach to the harmonious relation of the four gases. This relation has been gradually produced by salt or the hidden blue hydrogen imbedded in salt. The skin and characteristics of the Ethiopian mark the superior force of carbon and phosphorus; those of the Mongolian, of sulphur, or a combination of hydrogen and phosphorus; those of the Indian, of nitrogen and hydrogen. Through the same study of the natural relation existing between the four gases, all natural forms, from a microbe to a whale or elephant, may be understood."

In such fashion the materialists have endeavored to set aside all problems of the posthom phantom, by resolving them with the hopes and fears of man into gas, controlled by colored forces of chemical relation.

On the other hand, immaterialists claim that of all forms of fluidic forces personal magnetism is the most potent. It is shown by Mr. William Q. Judge that the astral light of the imagination can form images of all imaginable things, and these, by the magnetism of the will, can be clothed in matter through precipitation. These objects will readily fade away unless fixed by some permanent mordant. "The distinct image of every line of every letter or picture," says Mr. Judge, "is formed in the mind, and then out of the air is drawn the pigment to fall within the limits laid down by the brain, 'the exhaustless generator of face and form.'"

Mr. Dean found himself unwilling to differ from so high an authority as Mr. Judge, who,

more than any other recent investigator has sounded the limitless ocean of spirit. The facts, however, remain. To a materialist, on the one hand, he would say, "There are more things in heaven and earth than are dreamed of in our philosophy, surely far more than hydrogen, carbon, nitrogen and phosphorus." To an immaterialist he would emphasize this. There is not a posthom phantom which has not its double in material things. When the body decays the posthom disintegrates. When the tree falls its shadow with it, and there is no adequate evidence that a true shadow can be made by the precipitation of fine forms of matter on an image laid down in the brain.

A vision thus formed in the brain can surely have no digestive apparatus, no phantom is better attested than the donkey of St. Croix, who for several years after his actual death and burial was seen by several gentlemen wandering alone in its old pasture, cropping the flowers and shadows of the growing oats. Careful observations showed that the actual oats suffered no injury. It is not likely that the donkey would feed on oats unless it retained a stomach in which oats could be placed. Whether actually digested or not would affect the argument.

The images formed in the brain have no anatomy; and though, no doubt, actual matter is often precipitated upon them, in accordance with Mr. Judge's observations, the result is rather a picture than a posthom, only the side of the posthom image nearest the brain is actually developed and materialized. If Mr. Kardec had given close attention to the shadow of Tartuffe he would have found it a flat bas-relief or spiritus cameo instead of a figure in perspective.

That posthoms can accomplish at times great material results is beyond question. Under the head of the "geometry of phantoms," Dr. D'Assier makes the important

observation that "invisible projectiles hurled by posthoms produce mechanical effects as great as if they were of great bulk." This he shows is due to the fact that "all bodies have their phantasmal doubles, which the shade can detach and grasp. The garments it carries, the objects it holds in its hand, are phantasmal images borrowed from its former wardrobe or its former utensils. It is presumable that the same holds as to invisible projectiles; in lieu of stones they fling their duplicates."

It may seem surprising that the shadow of a stone could harm any one or produce any sort of a physical commotion. But here we are to remember that it is not the weight of a thrown object which tells, but its momentum. Its momentum is its weight multiplied by its velocity. "Its live force at the moment of fall," says D'Assier, "is equal to half the bulk multiplied by the square of its velocity." It is well known that the velocity of a living posthom may be scarcely less than that of a flash of light. The instantaneous apparition and disappearance of phantoms shows this. The true posthom never deliquesces, as the old-fashioned ghost is said to do, but in reality it moves away with much celerity. It is plain, then, that however light a shadow may be, it is a terrible weapon when hurled with almost infinite velocity by a disembodied posthom. Its concussion might be heard as a great shock, if flung with sufficient force. It is related that in the castle of Schreckheim, in Franconia, a posthom once entered the pantry on a shelf of which was the ancestral china of the noble house. Soon a mighty crash of breaking dishes arose. On entering the room the noble lord of the castle found everything in place. The excited posthom had merely flung down the phantasms of the different pieces of china, but with a force so mighty that the noise reverberated to the outer walls of the castle. It may be thought that the posthom

in question was that of a servant girl who had been deeply reproved for breaking a favorite teacup, and who, dying soon after, had this method of expressing her vanishing feelings. But, curiously enough, the servant girl whose posthom caused the disturbance recovered from her illness and lived to break many more pieces of rare china, in this and other castles to which she was sent by the intelligence office in Nuremberg. From this we may conclude that her illness was due to the temporary breaking of the vascular plexus which holds the posthom to the body, and that when her shadow came back from its rounds her health was promptly restored.

It is, in fact, certain that very many forms of disease, known as anæmia, neurasthenia, echolalia and the like are due to the temporary absence of the posthom shadow. It can be sought for by direct means, and it will usually be found engaging in absurd and freakish actions. An effective method of cure is to strengthen the degree of personal magnetism and to bring the shadow back by a strong effort of the will. Mental healing, mind-cure suggestion, astral magnetism and the like are forms of this process. Contact with certain relics has produced an odic shock which has served the same useful purpose.

In concluding this most interesting discourse, soon to be printed in full in the annals of the Club of Alcalde, the distinguished sage of Angels asserts that we shall do well to heed the wise words of Dr. Adolphe D'Assier: "Let us not be deceived by appearances and let us be on our guard that in exploring the domain of the shades we may not take a shade of reasoning for reasoning itself." For Logic as well as Magic has also its Phantasmal Double, and when truth dips wearily under oblique suns the two are apt to range very far apart.

DAVID STARR JORDAN.

STANFORD UNIVERSITY.

SCIENTIFIC BOOKS.

A Short History of Astronomy. By ARTHUR BERRY. New York, Charles Scribner's Sons. 1899. Pp. xxi + 440. Price, \$1.50.

Astronomy is a science whose history may be said to have been over-exploited. In French there are the great works of Delambre, La Place and Bailly, Biot and Tannery; in German, those of Jahn and Wolf, Epping and Strassmayer; and in English, mainly Grant's classic work, which won him the gold medal of the Royal Astronomical Society, Sir George Lewis's *Astronomy of the Ancients*, and Miss Clerke's admirable, accurate and delightfully readable history of astronomy during the 19th century, not to mention other and more recent works by Sir Norman Lockyer.

Clearly there could have been no clamor for a new history when Mr. Berry, an assistant tutor at Cambridge, England, undertook his task; if demand there was, it was rather the exigency of the 'University Series.' Had its volumes been twice their present size, and had Mr. Berry taken time to familiarize himself with originals, instead of compiling 'largely from second-hand sources,' as he has to admit, his book would still have been but a 'Short History'; but he might well have achieved a contribution of permanent worth, for he is by no means deficient in aptitude for the task. However, his confessed lack of knowledge of and sympathy for the observational side of the science has induced him to erect his edifice on insufficient foundations, so that homogeneity of structure is baldly impossible.

Although the illustrations number 120, there is no picture of a telescope save one a hundred years old and more; no statement of the principle of the achromatic telescope, without which the astronomy of to-day would for the most part have been non-existent; no mention of Dollond, its acknowledged inventor, nor of the greatest builders of telescopes—Grubb, the Henry Brothers, Steinheil—not even the Clarks. Spectroscopes, the very staff of the new astronomy, are singularly neglected. With this author, compression has been insistent, but it has largely been gained by deliberate and not very well considered exclusion. His work

thus produces an impression of being fragmentary rather than comprehensive.

Firstly, it seems unnecessary to have an initial twenty pages to sheer else found in, and only appropriate to, a mere book of secondary grade. The most astronomy is dismissed in rather superficial fashion, as was necessary. Archaic elementary mathematical conceptions are sketched, and the frequent biographic afford a much needed enlivening of the although of slender astronomical significance.

Mr. Berry perpetuates the old-time error regarding annular eclipses, by a diagram of an impossibly large sun centrally obscuring an impossibly small moon, still further darkened by impossible black spots on its surface (p. 59). The advances of Hipparchus and Ptolemy are excellently narrated. With the life work of Copernicus, Kepler, Galileo and Descartes is concluded the first half of the volume.

Naturally, the lives and works of Newton and the Herschels receive the fullest attention; but Mr. Berry fails to state the law of universal gravitation quite correctly, its most general form involving the product of the masses of the bodies concerned, not their sum (p. 60). And it would be rather difficult to defend the book against the charge of insularity, for English astronomers are accorded vastly more consideration than the Continental, let alone Americans, who are conspicuously passed over. We have only scanty space for a catalogue of especial omissions; but may mention, for instance, a German, the classic work of Schmidt and Schmidt on the moon, of Brünnow and C. Peters on stellar distances and the constants of astronomy, of Chladni upon meteors, of Encke upon the planets, of Heis upon meteoric showers, of stellar magnitudes, of D'Arrest and Laugier upon the nebulae, of Oppolzer upon eclipses, of Auwers upon stellar catalogues and other departments of exact astronomy, and of Spiller upon the sun, his remarkable 'law of zones' being nowhere alluded to. For France and Italy the omissions are less serious, though Gassendi, De l'Isle, Pingré, Lemonnier, Lalande, Le Boulle, Méchain, Oriani, Pons, Foucault and Deslandres were much better included.

ignored; while among Americans we look in vain for C. H. F. Peters and Watson, Benjamin Peirce and G. P. Bond, Olmsted and H. A. Newton, Rutherford and the Drapers, the Clarks and Gould, and Langley's epoch-making research on the infra-red rays of the solar spectrum.

When Mr. Berry reaches the 19th century, staggered by the accumulation of material, he deliberately abandons his task by attempting a summary in a single chapter. Here he scores a signal failure, in a sketchy agglomeration of fragments, with omissions quite as prominent as inclusions. As a running précis, or evanescent periodical paper, the chapter is excellent, though proportionately out of balance with the preceding twelve chapters. Parts of Mr. Berry's book are so well done that a subsequent edition would be quite worth an expansion or sub-division of this chapter, for the sake of appropriate exposition of the 'New Astronomy,' and the instrumental means that alone have made its marvelous revelations possible. Had the whole of Mr. Berry's short history been compressed proportionately to this chapter, the book would have been but one-third its present size. Solar research, in particular, is dismissed very cavalierly.

Every one using Mr. Berry's compend for reference would appreciate a new index. A double index is a mistake. But a greater one is the baffling system of reference, wholly ignoring the pages of the book, and increasing at least fourfold the time and labor of finding any indexed allusion to a name or subject. What is printed is simply an index to the MS., not to the printed volume itself; whereby the author has saved his own time and that of his helpers, but has wasted that of everybody who attempts to use his book as a reference work. The same remark applies to frequent cross-references throughout the volume, which would otherwise have been most helpful.

Misprints are, fortunately, few, but we find preserved and dignified that widespread error of the common kind that the navigator gets his longitude from solar sights at apparent noon: were all navigators to follow this method, and no other, we wonder how many ships would escape being put ashore. Nine excellent por-

traits of astronomers adorn the book, from Copernicus to Sir William Herschel.

DAVID P. TODD.

AMHERST COLLEGE.

De la methode dans la psychologie des sentiments.

Par F. RAUH. Paris, Felix Alcan. 1899.

This book is not what the title would suggest, a monograph on Method in the Psychology of Emotion, but a general summary and discussion of theories of emotion, particularly of recent theories, and of methods so far as involved. After some introductory definition M. Rauh takes up the physiological, intellectual, the biological or voluntarist, and the specialist theories, if we may summarize the theories by abridging his terms. His critique of the physiological, or organic, theory of the James-Lange school is quite full. He concludes: "On peut dire qu'une des caractéristiques de la physiologie physiologique a été la superstition du mouvement, en particulier du mouvement musculaire. Si au lieu de considérer les relations des faits de conscience et des mouvements périphériques, on considère celle des faits de conscience et du cerveau, nous avons vu combien cette correspondance est complexe et encore obscure. Ce qui fait croire que l'on peut expliquer scientifiquement les sentiments et en général les faits de conscience par les mouvements organiques, c'est que ces mouvements marquent en effet la limite d'action des faits psychiques." (P. 148.)

As to the intellectual interpretations of emotion, whether from the side of sensations or ideas, he regards this as of much more importance than the psycho-physiologists allow. It may be called a universal interpretation, though not an explanation. In this he follows a rather disputable distinction of theories. "Nous désignerons les théories, qui traduisent les faits sans permettre de les prévoir, du nom de théories *interprétatives*; nous appellerons théories *explicatives* celles qui permettent de les prévoir" (P. 27). But a mere formal or descriptive interpretation scarcely deserves the term theory. The biological principle of the struggle of existence is discussed at some length and granted some place, but not regarded as universal. He emphasizes such exceptions as

the neurasthenic and sea-sick, with whom emotion is a desire of death rather than life. But we do not think that these and other instances (*e. g.*, play, p. 281) interfere with the general theory that the origin and development of normal emotion is by its life significance. He identifies the voluntarist with the intellectualist theory. "Un organe tend à être, c'était en réalité dire: il y a une pensée dans cet organe qui le veut tel ou tel: l'être qui tend à être est toujours une pensée. Les sentiments indécomposables, irréductibles à toute explication physiologique ou intellectualiste—qui en un sens existent, comme nous l'avons pu conclure de ce qui précède, comme nous le verrons mieux dans le chapitre suivant—impliquent eux-mêmes une traduction intellectualiste." In the next chapter here alluded to he treats of emotion as special, *sui generis*, indecomposable facts of consciousness. He regards 'sentiments proprement dits' as those which are either unanalyzable or whose quality cannot be determined from their component parts. Such emotions are love, friendship, etc., but which are to be studied both from the organic and intellectual points of view. M. Rauh's general conclusion is that analysis is the indispensable preliminary in the study of emotion. This should be followed by tracing them to their organic and intellectual causes and learning the mode of causal action, or, when emotions are unanalyzable, their causal action should be traced. But in all this we must remember that psycho-physiology can only show the body as limit, but not as real cause or even always as measure of emotion. Psychology, here as elsewhere, seeks not unity, but actual practical prevision.

While M. Rauh's work appears to us too cursory and discursive, covering too wide a field and reaching too vague and eclectic conclusions, yet it shows considerable thought, and ought to be suggestive to the student of Emotion.

HIRAM M. STANLEY.

BOOKS RECEIVED.

Talks to Teachers on Psychology; and to the Students on some of Life's Ideals. WILLIAM JAMES. New York, Henry Holt & Co. 1899. Pp. xi + 3-1.

Defective Eyesight. D. B. ST. JOHN ROOSA, M.D. New York and London, The Macmillan Company. 1899. Pp. ix + 186.

Le Climat de la Belgique en 1897. A. LANC. Brussels, Hayez. 1898. Pp. 202.

La Spécificité Cellulaire. L. BARD. Paris, G. and C. Naud. 1899. Pp. 100.

La Sexualité. F. LE DANTEC. Paris, G. Carré and C. Naud. 1899. Pp. ix + 98.

La Théorie de Maxwell et les oscillations Hertziennes. POINCARÉ. Paris, G. Carré and C. Naud. Pp. 80.

SOCIETIES AND ACADEMIES.

AMERICAN MATHEMATICAL SOCIETY.

IN the month of April the American Mathematical Society held two meetings. On Sunday, April 1st, the Chicago Section of the Society held its spring meeting at Northwestern University, Evanston, Ill., and on Saturday, April 29th, the regular April meeting of the Society was held at Columbia University, New York City. At the latter meeting, guarantee of support having been received from a number of universities, the final steps were taken for the publication of the *Transactions* of the Society. The Board of Editors appointed by the Council consists of Professors E. Moore, E. W. Brown and Thomas S. Fiske. The first number of the *Transactions* will appear in January, 1900. The *Bulletin* of the Society will hereafter be devoted more exclusively to the publication of critical and historical material and to very short original articles, especially such as present in concise form results of general interest or importance.

At the meeting of the Chicago Section the following papers were read:

- (1) DR. HARRIS HANCOCK: 'Primary function'
- (2) PROFESSOR E. W. DAVIS: 'The group of trigonometric functions.'
- (3) PROFESSOR H. MASCHKE: 'On the continuity of a power series.'
- (4) DR. KURT LAVES: 'Lagrange's differential equations for a solid of variable form derived from Hamilton's principle.'
- (5) PROFESSOR E. H. MOORE: 'The decomposition of modular systems connected with the generalized Fermat theorem (second communication).'
- (6) PROFESSOR JAMES B. SHAW: 'Some generalizations in multiple algebra and matrices.'
- (7) PROFESSOR J. W. A. YOUNG: 'On the representations of the fundamental principles of calculus.'

- (8) PROFESSOR A. S. HATHAWAY : 'A new method of presenting the principles of the calculus.'
- (9) PROFESSOR E. H. MOORE : 'On the subgroups of abelian groups.'
- (10) MR. CARL C. ENGBERG : 'A modification of the theory of the characteristics of evolutes (preliminary communication).'
- (11) DR. L. E. DICKSON : 'Certain universal invariants of linear modular groups.'
- (12) DR. L. E. DICKSON : 'Concerning the four known simple groups of order 25,920.'

The following is a list of papers read at the New York meeting of the Society :

- (1) DR. J. I. HUTCHINSON : 'The asymptotic lines of the Kummer surface.'
- (2) DR. L. E. DICKSON : 'The known finite simple groups.'
- (3) MR. E. B. WILSON : 'Note on functions satisfying the equation

$$\phi(x)\phi(y) = \phi(x+y).'$$

- (4) DR. A. S. CHESIN : 'On the differential equation of dynamics.'
- (5) PROFESSOR CHARLOTTE ANGAS SCOTT : 'A proof of Noether's fundamental theorem.'
- (6) DR. G. P. STARKWEATHER : 'Non-quaternion systems containing no skew units.'
- (7) PROFESSOR E. GOURSAT : 'Sur la définition générale des fonctions analytiques d'après Cauchy.'
- (8) PROFESSOR F. MORLEY : 'The value of

$$\int_0^{\pi} (\log 2 \cos \phi)^m \phi^n d\phi.'$$

- (9) PROFESSOR E. W. BROWN : 'An elementary illustration of the connection between the current and the height of the water in a tidal estuary.'
- (10) DR. W. M. STRONG : 'The determination of non-quaternion systems in six units.'
- (11) PROFESSOR E. O. LOVETT : 'Curves of multiple curvature.'
- (12) PROFESSOR JAMES PIERPONT : 'Elliptic functions.'
- (13) MR. C. J. KEYSER : 'On a definitive property of the covariant.'

The summer meeting of the Society will be held at the State University of Ohio, Columbus, Ohio, on Friday and Saturday, August 25th and 26th, in affiliation with the meeting of the American Association.

F. N. COLE,
Secretary.

COLUMBIA UNIVERSITY.

THE NEW YORK ACADEMY OF SCIENCES—SUB-SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

A REGULAR meeting of the sub-section was held April 24th, in association with the Anthropological Club.

The first paper was read by E. A. Gerrard, and gave methods for the study of emotional expression as found in literary compositions. The relative emotional values of the different parts of speech, of different sentence lengths, and other variations in the kind of language used and in its arrangement, were discussed and illustrated by curves derived from a number of writings.

S. I. Franz presented some results of experimental investigations of visual after-images. The latent period increases as the area of stimulation decreases, but decreases as the intensity and duration of stimulation increases. The duration of the after image increases with any increase in the intensity, duration and area of the stimulation. The after-image of the colors in the middle of the spectrum is not more intense than that of the extreme colors if the intensity of the colors is first equalized. The degree of attention is of the first importance in determining the duration of the after-image. Retinal transference is not real; its apparent reality is due to the impossibility of distinguishing the fields of vision of the two eyes.

J. R. Swanton discussed the structure of the Chinook language. Discourse in this language shows great lack of subordination, its short sentences following each other without connectives. The verbs are aggregations of many pronouns added to a short stem. They serve in this way to epitomize the whole sentence, object and indirect object, as well as subject.

Stansbury Hagar read a paper on the Astronomical Cosmogony of the Peruvians. The paper aimed to show the large amount of astronomical knowledge possessed by the Peruvians and the intimate relations between their ritual and political life and their astronomy.

CHARLES H. JUDD,
Secretary.

PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 501st meeting of the Philosophical Society of Washington was held at the Cosmos Club on April 29th. An informal communication was first made by the Secretary on Recent Geodetic Operations in Spain, special attention being given to the Base of Madrideojos and to the Triangulation connecting Spain and Algiers. The results from the Base Measurement showed it to be one of extreme accuracy. The manner in which the work was carried out threw new light on the most desirable lengths of Base Lines in general, inasmuch as it was shown that greater economy with equal accuracy can be attained by measuring short lines and expanding them by careful triangulation. The geodetic connection across the Mediterranean was made the occasion to demonstrate that longitudes may be determined by means of optical signals quite as accurately as by the electric telegraph.

The first regular paper of the evening was by Mr. J. F. Hayford. The author made a statement of a new treatment of refraction in trigonometric-height computations recently used by the Coast and Geodetic Survey in connection with triangulation in Colorado, Utah and Nevada, involving lines of sight from 100 to 182 miles long. The term of the strict formula (See Wright's Adjustments, p. 387), which involves the square of the distance and the difference of the refraction coefficients at the two ends of the line, and which is usually neglected, was here retained with marked improvement in the results. It was assumed that the refraction coefficient is a linear function of the height of a station above sea level and of the air temperature at the station.

The second paper was by Dr. H. S. Pritchett, on 'An estimate of the population of the United States in 1900 derived from an empirical formula.' Dr. Pritchett first called attention to the general form of the curve defining the relation between the population and the time. The data now at hand enabled the author to write eleven conditional equations of the form

$$p = A + Bt + Ct^2 + Dt^3$$

where p represents the population (the unit being one million), t is the time counted from 1840 the epoch of the sixth census results and A B

C and D are constants to be determined. solution of the normal equations led to the following empirical formula

$$p = 17.4841 + 5.102t + 0.63t^2 + 0.030t^3$$

Attention was called to the very close agreement between the curve and the actual position at the time of taking the census, the largest discrepancies being in 1860 and 1880. Both these values were abnormal, partly because of the exceptional conditions then existing Civil War, lack of immigration, etc., and partly on account of inaccurate census results in or both cases.

The differentiation of the formula brought out the fact that the rate of increase is continually growing less, having fallen off from 32% per decade in 1790 to 24% in 1890.

The result of the investigation was that the best value for the population of the United States in 1900, based on its growth since 1790, is 77,472,000 with a probable error of about 250,000. As a matter of curiosity the author added that if the same law holds good in the future we would have in 1990 a population of billions, in the year 2500 nearly 12 trillions at the epoch 2900 this already appalling figure will have grown to such an extent that there will, on the average, be 11,000 inhabitants to the square mile.

The third paper by Professor J. H. Gore 'Geodetic Work in Spitsbergen,' was not given on account of lack of time. Professor Gore, however, showed a number of interesting lantern slides illustrating his recent visit and scientific work in that country. The paper will be given at a subsequent meeting of the Society.

E. D. PRESTON,
Secretary

DISCUSSION AND CORRESPONDENCE.

PROFESSOR JAMES ON TELEPATHY.

TO THE EDITOR OF SCIENCE: It is evident that Professor James and I have been writing at cross purposes. On the point that Lehmann has not 'established' his explanation of Sidgwick's results I am heartily at one with James, Sidgwick, Parish and Lehmann himself. But Professor James need not have awaited my return mail from Copenhagen to wrestle

admission either from Lehmann or from me. Lehmann wrote in his original paper: "Ein exacter Beweis hierfür (*i. e.*, for his explanation) kann wohl im Augenblicke nicht geführt werden." Nor, I take it, in any future Augenblick.

On the other hand, I have never regarded this point as the point at issue. Lehmann set out to examine telepathy at large. He chose the Sidgwick experiments simply as typical series, considering the authors' names a guarantee of serious intent and careful work. In his inquiry he laid hold of a condition which had never been thoroughly investigated before, and traced its effects in experiments that were both ingeniously devised and rigidly controlled; no one can neglect the unconscious whisper in future telepathic work. His paper is a model of scientific method; he has shown us how borderland questions are to be attacked, and proved that the 'ordinary channels of sense' have unexplored resources. His suggestions will be fruitful, for the next stage of advance must be an exhaustive study of the 'number habits' which Sidgwick at first rejected, but now makes the headstone of the corner. Even granting all the contentions of the critics, therefore, I should assert that Lehmann's work is brilliant, and that it has done signal service to scientific psychology. But, as I hinted before, I do not know that quasi-mathematics has contributed much to psychology in any field of research.

I conclude with a word on the logic of Professor James' objection. A theory is propounded which, from the outset, lays claim to probability and to probability only. 'Exact proof' is acknowledged to be impossible. Criticism plays upon the theory, and the author again acknowledges that his hypothesis is not proven. Professor James, apparently forgetting the first acknowledgment, affirms that the criticism has 'exploded' the theory! What is not proven is, *eo ipso*, exploded! Is Professor James, then, ready to grant that his recent book on 'Human Immortality'—something which assuredly is not yet proven—is an 'exploded document'? If the alternatives before me are scientific isolation and companionship on these logical terms I prefer the isolation. E. B. TITCHENER.

NOTES ON PHYSICS.

THE COMPENSATION PYRHELIOMETER.

MOST of the measurements heretofore made upon radiant energy by means of the thermopile or bolometer are relative rather than absolute in character, and the necessity for a simple and accurate method for reducing the indications of such instruments to the usual thermal units has long been felt. On this account a paper by Knut Ångström (*Wied. Ann.*, No. 8, Band 67) in which he describes an instrument for measuring radiation in absolute units is of great interest. This instrument, to which he has given the name of Compensation Pyrheliometer, is apparently simple in construction, and the results obtained from it are very reliable, the maximum error, as the author states, not exceeding 2%.

The construction of the instrument is briefly as follows: Two equal, thin (.001 to .002 mm.), blackened strips of platinum are mounted in such a manner that either or both, by means of appropriate shutters, can be exposed to the radiation to be measured.

One of the two junctions of a small constantin-copper thermo couple is attached to each of the rear surfaces of the platinum strips, the circuit of thermo couple including a galvanometer. It is evident that if one of the platinum strips is exposed to radiation the equality of temperature at the junctions is destroyed and the galvanometer is deflected. A current of electricity is now made to traverse the unexposed strip, and the strength of the current is adjusted until the galvanometer returns to zero. Under these conditions the two junctions are receiving the same amount of energy per second, and the heat developed by the current in the unexposed strip is equal to that given to the exposed strip by the radiation. A knowledge of the strength of the current and of the resistance of the strip suffices to find the value of the radiation in gramme calories per square centimeter per second. Since the strips are alike in all respects and are subjected to identical conditions, no corrections are necessary.

An interesting result obtained by Ångström is the value of the mean horizontal radiation of a Hefner normal lamp, which comes out to be 18.2 gm.-cals. per square centimeter per minute

at one centimeter distance. This value seems to be very constant, and the Hefner lamp may possibly become a standard of *total* as well as of *luminous* radiation.

A. ST. C. D.

NOTES ON INORGANIC CHEMISTRY.

Two papers have appeared in the *Journal of the American Chemical Society*, by Dr. F. P. Venable, on the 'Nature of Valence.' The idea of valence in chemistry has been of gradual growth and has merely been the expression of certain chemical facts. In the case of the carbon compounds and in organic chemistry in the hands of Kekulé it has proved of immense service, and without it the wonderful development of this field in the past three decades would have been impossible. Its application to inorganic chemistry has been hardly as happy, and the original conception of a fixed valence has been abandoned for that of variable valence, but even this is limited to comparatively simple compounds. As an explanation of the structure of double salts, water of crystallization, metal-ammonia bases and other complex inorganic compounds it is wholly inadequate and possibly a hindrance. While in one form or another the conception of valence has permeated and, one might almost say, dominated chemistry, little or nothing has been known regarding its nature. To be sure, in the last decade or so several hypotheses have been offered by van't Hoff, Wislicenus, Victor Meyer, Knorr, Flawitzky and a few others, attributing valence to electrical phenomena, space relations of the atom, etc., but none of these attempted explanations has received any measure of support. The hypothesis which Dr. Venable puts forth is that valence is dependent upon vibratory (or kinetic) equilibrium of the atoms. "The question as to whether the atoms of two elements will unite is decided by affinity which is in some way connected with the electrical condition of the atoms. There is no apparent connection between this and valence." But the atoms "are endowed with motion, and this motion probably varies in velocity and phases with the different elements." "A molecule, in order to exist, must maintain a certain equilibrium and harmony between these various mo-

tions, so that there can be all degrees of librium from the very stable to that which be upset by the least disturbing influence without." Variable valence will be, in at least, dependent upon the temperature a "sufficiently high temperature may produce any harmony of motion, whatever being attained and hence union may become impossible. Valence would then be dependent upon possible harmony of motion between the constituent atoms. The hypothesis is simple and factorily explains many at least of the facts; thus, for instance, the zero valence of elements like argon and helium might be due, not to their possessing no chemical affinity (though this may be the case), but to their motion being capable of harmonizing with that of other elements. The weak point of the hypothesis is the difficulty of proving it to be true; it would be necessary to first know the nature of the motion of the atom, a problem yet unsolved. It is possible that the spectroscope could do this, but at present we have no clue as to why some elements, as iron, furnish a complex spectrum while others, like sodium, give a relatively simple one. At all events Dr. Venable's idea furnishes a good and simple working hypothesis, and which may have its practical uses for teaching.

ATTENTION should be called to the *Supplement* to Dr. H. Carrington Bolton's *Bibliography of Chemistry, 1492-1892*, which has just been published by the Smithsonian Institution. It includes works omitted in that volume, and brings the literature of chemistry down from 1892 to the close of 1897. Dr. Bolton has been fortunate in having the cooperation of a number of scholars abroad, who have contributed more than 2,000 titles in American, Finnish, Japanese, Bohemian, Dutch, Portuguese, Swedish, Danish, Norwegian and Russian, no less than 760 titles in the latter language being furnished by Professor A. Krup of St. Petersburg. Dr. Bolton's bibliographical work is invaluable to chemists and is carried out in a manner which is above criticism.

PROFESSOR F. EMICH, of Graz, has been kind enough to send me a paper from his laboratory by F. Dörner, with a chemical investigation of the cement from antique water conduits.

material was collected by Dr. P. Forchheimer during an exploring tour in Asia Minor, and was from Ephesus and Smyrna. The different specimens may have been from different periods, from several centuries before Christ to three centuries after Christ, but the general composition of all was the same. The mineral matter was chiefly calcium carbonate, but from 2 to 8 per cent. of organic material was present. This proved to be merely a mixture of fatty acids, and gave evidence that the cement was the oil-cement mentioned by early writers, as Pliny and Vitruvius. A series of experiments showed that a cement of burned lime and olive or linseed oil was not permanent, but that a mixture of two-thirds air-slacked lime and one-third olive oil hardened rapidly and was very durable. It is probable that this was approximately the mixture used in the ancient cements examined.

J. L. H.

BOTANICAL NOTES.

WOOD'S HOLL BOTANY.

It is encouraging to note the continuation of the good work in botany which has been a feature of the Marine Biological Laboratory at Wood's Holl, Mass., and to observe that from year to year it is gaining in strength, both as to kind and quality. This year, beginning on the 5th of July, work is offered in the following lines, viz. :

1. Plant Morphology and Physiology, including the Cryptogams.
2. Lectures on the Algae, with a study of many types.
3. Plant Cytology, for advanced students.
4. Special Investigations.

The first course should be especially helpful to students and teachers, since it will afford an opportunity of meeting and hearing many of the men who are adding to our knowledge of plants in many departments of botany. It is worth much to learn something of the personality, methods of work and point of view, of such men as B. M. Davis (algæ), E. F. Smith (bacteria), D. T. MacDougal (physiology), D. H. Campbell (evolution of plants), L. M. Underwood (liverworts), H. J. Webber (fecundation

in gymnosperms), G. F. Atkinson (higher fungi), D. M. Mottier (cytology), and D. P. Penhallow (paleobotany), and the teacher who does so cannot fail to carry into his class-room next year an inspiration to higher and better work.

CORN PLANTS.

MR. FREDERICK LEROY SARGENT has brought out a pretty and timely little book on 'Corn Plants, their Uses and Ways of Life,' which should be widely used as a supplementary reader in the schools. Unlike many supplementary readers, this one is written by a man who 'knows what he is writing about,' and hence the reader is not shocked by grossly inaccurate statements or crude misinterpretations. It is a thoroughly commendable little book.

The following headings of some of the sections of the book will give an idea of its scope and the treatment of the subject: 'What Corn Plants are'; 'Corn Plants in the Field'; 'How Corn Plants Provide for their Offspring'; 'Wheat, the King of Cereals'; 'Barley, the Brewer's Grain'; 'Rice, the Corn of the East'; 'Maize, the Corn of the West'; etc.

The publishers (Houghton, Mifflin & Co.) have done their share in typography and binding to make this one of the most attractive books of the season.

CANADIAN BOTANY.

FROM the Curator of the Herbarium of the Geological Survey of Canada we have recently received the following papers, viz. : 'Contributions to Canadian Botany,' XI. and XII., by James M. Macoun, containing many new or hitherto unrecorded species (nearly all the new species were previously described by Professor Greene in *Pittonia*); 'The Cryptogamic Flora of Ottawa,' by John Macoun, including 220 species of mosses, 55 liverworts and 152 lichens; 'Notes on Some Ottawa Violets,' by James M. Macoun, devoted to the seven species of violets formerly included under the familiar *Viola cucullata* of the older mammals. These species are *Viola septentrionalis*, *V. macounii*, *V. venustula*, *V. cucullata*, *V. cuspidata*, *V. affinis*, *V. populifolia*. Admirable plates accompany the descriptions and make clearer the characteristics by which they are distinguished.

THE SOCIETY FOR THE PROMOTION OF AGRICULTURAL SCIENCE.

NEARLY twenty years ago (September, 1879) half a dozen men conceived the idea of organizing a society of scientific men, the object of which should be to promote agriculture by fostering investigation in science applied to agriculture. As a result the Society for the Promotion of Agricultural Science came into existence, and its members have met once a year in connection with the American Association for Advancement of Science. Last August the Society held its nineteenth meeting, at which the President, Dr. B. D. Halsted, presented a historical summary of the work accomplished since its organization. In this time (not including the Boston meeting last year) the members presented and the Society published 278 papers. It is gratifying to the botanists to know that of this number 102 dealt with botanical problems. These were grouped as follows: Structure and physiology, 26; agrostology, 16; pathology, 43; weeds, 7; seeds, 10. The following titles taken almost at random from the list of botanical papers will show that the botanist who wishes to have copies of all important botanical publications must include those which have appeared in the Proceedings of this Society: 'Variations in Cultivated Plants,' 'Notes upon the Flowering Plants of Ohio,' 'Notes upon Bean and Pea Tubercles,' 'The Agricultural Grasses of Arizona,' 'Grasses and other Forage Plants best adapted to endure Drouth,' 'A Tomato Disease,' 'The Scab of Wheat Heads,' 'New Experiments with Fungicides for Smut of Wheat and Oats,' 'The Weedy Plants of Ohio,' 'The Vitality of Seeds Buried in the Soil,' 'Delayed Germination of Cocklebur.'

CHARLES E. BESSEY.

THE UNIVERSITY OF NEBRASKA.

THE FORESTS OF CANADA.

THE United States Consul at Montreal, Mr. Bittinger, has sent to the Department of State a report showing the distribution of forests in Canada and throughout the world. The following table shows the area of the forests in the different Provinces:

Province.	Total area.	Woodland.	Per cent.
	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Per cent.</i>
Ontario.....	219,650	102,118	
Quebec.....	227,500	116,521	
New Brunswick...	28,100	14,766	
Nova Scotia.....	20,550	6,464	
Prince Edw. Is.....	2,000	797	
Manitoba.....	64,066	25,626	
British Columbia..	382,300	285,554	
N'w'west Ter.....	2,371,481	696,952	
Total	3,315,647	1,248,798	

The quantity of pine is estimated, in Ontario as 19,404,000,000 board feet; in Quebec 15,734,000,000 feet; in the other Provinces 2,200,000,000 feet; total, 37,338,000,000. A low calculation of the annual cut is 1,000,000 feet, in which case Canada has more than forty years' supply, and the growth of new wood, in spite of all regulations, is nearly equal to the cut. It is impossible to give anything like a just return of the supply limits, estimates being so diverse as to be less.

The great tree of Ontario is the white Weymouth pine. There are also the red spruce, hemlock, etc. The valuable hard wood trees, such as walnut, tulip, plane and coffee trees are all extinct. The quantity or value of timber cannot be given, as many millions of acres are utterly unexplored. In the known wood return to the Ontario government states that there are 60,410,000,000 feet.

Quebec, with its newly added territory, is now an even larger Province than Ontario. The white pine is the most important tree, and in Ontario; it is, however, rapidly disappearing. Rich spruce is noted in Bonaventure River, Bouleau, Chicoutimi county, River French Bay Lake. There is great waste of hemlock on account of its bark.

Some of the best cedar areas of the country are on the north shore of New Brunswick. An unsurveyed area of some 2,000,000 acres on the Upper Restigouche is reported to be full of spruce and cedar. The pine forests, at one time rich, have been greatly impoverished. The same is true of Nova Scotia. A quantity of good spruce is left in the last-named Province but it is being used in a similar way.

British Columbia may be said to possess the largest compact timber resources in the world. Only the fringe has been cut. It is estimated that the Douglass pine, cedar, spruce, Alaska pine, etc., standing in the railway belt, amount to 25,000,000,000 feet, worth \$25,000,000. The coast is heavily timbered as far north as Alaska. There is no white pine, but spruce attains perfection in this section.

The following table shows the area in forests in various countries of the world :

Country.	Acres in forests.	Percent'ge of total area.
<i>Europe.</i>		
Austria	24,172,360	32.58
Hungary	18,777,771	23.52
Belgium	1,243,507	17.08
Bulgaria	3,291,100	12
France	23,466,450	17.92
Germany	34,347,000	25.70
Greece	2,025,400	12.60
Italy	10,131,235	14.31
Norway	19,288,626	24.53
Portugal	1,163,841	5.25
Roumania	4,942,000	15.22
Russia	498,240,000	37.15
Servia	5,763,163	48
Spain	16,354,941	13.03
Sweden	44,480,000	40.65
Switzerland	2,259,018	20.12
Turkey	3,500,000	8.93
United Kingdom	2,695,000	4
<i>America.</i>		
Canada	799,230,720	37.66
United States	450,000,000	23.29
British Guiana	5,760,000	18
<i>Asia.</i>		
India	140,000,000	25
Turkey	17,500,000	.....
Japan	28,700,000	30.24

AN EXHIBITION OF GEOGRAPHICAL AND GEOLOGICAL MATERIAL.

THE City Library Association of Springfield, Mass., has recently erected a fine building, which is to be devoted to the display and use of collections in Natural History. As some interval of time must elapse before the collections can be installed, there has been arranged in the main museum hall — 123x47 feet in dimensions—an attractive and instructive exhibition

of material which illustrates the rapid advance in geography and geology.

A study of this collection of maps and publications reveals great activity on the part of government and publishers in map-making and in the adaptation of recent discoveries for the use of school and colleges. An opportunity is offered to compare the technique and scope of the surveys and maps made by the United States, England, France and Germany. There are displayed a number of sheets of the Ordnance Survey of England and many staff maps from Germany and France. The clearness with which a multitude of details is shown on these productions is remarkable. Then the results of the topographical survey of the United States are shown in a carefully selected series of atlas sheets. The geographers of this country have taken up with much zeal the task of classifying various land forms. That such a proceeding is hedged round with difficulties is easily apparent. The best success has been had where the relative development of a region has been made the test in classification. Among the sheets on exhibition are several selected by Henry Gannett, chief geographer of the United States. Use has also been made of the recent work of Professor W. M. Davis, of Harvard University.

There is in the exhibition material which illustrates recent progress in geology. The exhibit made by the United States Geological Survey at Omaha has been loaned for the purposes of this exhibition. There are also examples of the work of the Geological Surveys of Great Britain, of Canada, of Germany and of many of the State governments. Especially fine work has been done in New Jersey under the direction of John C. Smock, and in Maryland by William Bullock Clarke. Professor B. K. Emerson, of Amherst College, has loaned his valuable manuscript maps on the geology of old Hampshire county, in Massachusetts.

There is also a very complete exhibition of the works of the best map makers in this country and abroad, and a number of relief maps. The Association cordially invites all persons interested in geography and geology to visit the exhibition, which it is now planned to continue until July 1st.

SCIENTIFIC NOTES AND NEWS.

DR. A. C. LANE has been appointed State Geologist of Michigan in succession to Dr. L. L. Hubbard.

PROFESSOR F. L. O. WADSWORTH has resigned his position on the staff of Yerkes Observatory.

A BRONZE tablet, placed by the Corporation on the house in Bath in which Sir William Herschel once lived, was unveiled on April 22d. Sir William Ball made an address, in the course of which he stated that it was in the back garden of this house that the planet Uranus had been discovered and many other important astronomical observations had been made.

THE death is announced of Dr. Friedrich Karl Christian Ludwig Büchner. He was born in 1824 and after practicing medicine became docent at Tübingen, from which position he was dismissed in consequence of the materialistic doctrines in his book on 'Matter and Force,' published in 1865. Thereafter he practiced medicine at Darmstadt. Büchner was well known for his series of popular works on physical science and the theory of evolution, as well as for numerous contributions to physiology, pathology and other sciences.

PROFESSOR CHARLES FRIEDEL, the eminent French chemist, has died at the age of sixty-six years. Born at Strassburg, he studied chemistry in Paris under Wurtz and became a curator of mineralogy in the School of Mines and in 1884 professor of organic chemistry at the Sorbonne. He was elected member of the Paris Academy in 1878, succeeding Regnault. He made important contributions to organic chemistry and was much interested in applications of chemistry to the arts.

MR. JAMES HOGG, a well-known London ophthalmic surgeon and writer upon scientific topics, died in London on April 23d, aged 82 years. In addition to numerous publications on diseases of the eye he wrote many books, including 'A Manual of Photography' (1845), 'A Manual of Domestic Medicine' (1848), 'English Forests and Forest Trees' (1853), 'Experimental and Natural Philosophy' (1854), 'The Microscope, its History, Construction and Applications' (1854, the 15th edition 1898),

'Colour Blindness' (1863), 'Boarding-Pauper Children' (1870), 'Microscopic Examination of Water' (1874) and 'Arsenical Paper Poisoning' (1879-89).

PROFESSOR G. C. SWALLOW, who has State Geologist of Missouri and Kansas and professor in the University of Missouri, died April 20th, at the age of 82 years.

WE regret also to record the following deaths: Dr. Rijke, professor of natural history, at Leiden, at the age of 85 years; botanist Dr. Gremley, at Egelschoten, aged 83 years; Surgeon-Major Dr. C. C. Wallich, 83 years; Graf Abbé Castracane at Rome; Dr. L. v. Babes, sometime professor of chemistry at the University of Freiberg, aged 80 years; Dr. M. D. Lwow, professor of chemistry in the Institute of Technology in St. Petersburg; Mr. Joseph Wolf, the naturalist and illustrator of many important English works on natural history.

THE Cambridge Anthropological Expedition under Dr. A. C. Haddon has arrived at Singapore on its way to England.

MR. EDWARD H. HARRIMAN, of New York, has invited a number of scientific men to accompany him as his guests on an expedition to Alaska. The party will leave Seattle about the end of May, on a large steamer chartered and fitted up specially for the expedition. The object is to take the 'inside passage' route to the Panama Canal, and then, after visiting Sitka, proceed westward along the coast to Yakutat, Prince William Sound, Cook's Inlet and Ketchikan Island. Numerous places will be visited which are out of reach of ordinary travelers, and facilities will be made to admit of scientific work. Steam launches, tents, camp outfit, packers and sleds have been bountifully provided, so that the largest amount of work may be done in the shortest time. Among those who have accepted Mr. Harriman's generous invitations to go on this expedition are Professor William Brewster, of Yale; John Burroughs, the well-known writer; F. V. Coville, Botanist of the U. S. Department of Agriculture; Dr. Wilbur H. Dall, of the Smithsonian, who has already visited Alaska 13 times; W. B. Devereux, Mining Engineer; D. G. Elliott of the F.

Columbian Museum, Chicago; Professor B. K. Emerson, of Amherst; Professor Bernard E. Fernow, Dean of the School of Forestry, Cornell University; Dr. A. K. Fisher, Ornithologist U. S. Biological Survey; Henry Gannett, Chief Geographer U. S. Geological Survey; G. K. Gilbert, Geologist U. S. Geological Survey; Dr. George Bird Grinnell, editor *Forest and Stream*; Charles A. Keeler, Custodian of the Museum of the California Academy of Sciences; Dr. C. Hart Merriam, Chief U. S. Biological Survey; Dr. Lewis R. Morris, of New York; Robert Ridgway, Ornithologist U. S. National Museum; Professor W. E. Ritter, of the University of California, and Professor William Trelease, Director of the Missouri Botanical Garden. In addition to these men of science and their assistants, two artists accompany the expedition, the landscape artist R. Swain Gifford, of New York, and the bird artist Louis Agassiz Fuertes, of Ithaca.

MR. RUSSELL W. PORTER writes that he will conduct, during the coming summer, an expedition under the auspices of the Peary Club, the main object of which is to communicate with Lieutenant Peary. The steam-bark whaler *Hope* will leave Sydney, Cape Breton, about July 15th. She will then go directly north, through the Gulf of St. Lawrence, up the Labrador coast, through Baffin's Bay, to the west Greenland coast, stopping probably at Upernavik, and then enter Melville Bay. After passing through Melville Bay the ship enters Whale Sound, where she will cruise until communication is made with Lieutenant Peary or his Eskimo representatives. The expedition will reach Sydney on its return at the end of September. The party will be limited to six and there is at present one place vacant. While intended primarily for hunting, the expedition will afford an excellent opportunity for work in natural history. Any man of science who would like to join the party should communicate with Mr. Russell W. Porter, 6 Beacon St., Boston.

A STATE Bacteriological and Pathological Laboratory has been established for Delaware. Professor Chester, State Bacteriologist, has been appointed director.

WE learn from the *American Geologist* that

the State of Wisconsin has appropriated the sum of \$100,000 for two years to carry on the new geological and natural history survey of the State, of which Professor A. E. Birge, of the University of Wisconsin, is director.

THE Liverpool School of Tropical Medicine was formally opened on April 22d by Lord Lister. A visit was made to the Tropical Diseases ward in the Royal Southern Hospital and to the Thompson-Yates laboratories, and a banquet was given in the evening, at which Lord Lister made the principal speech.

DR. GEORGE BRUCE HALSTED has been invited to present a Report on Progress in Non-Euclidean Geometry at the coming Columbus meeting of the American Association for the Advancement of Science.

THE Paris Society of Biology has awarded its Godard prize for the most important contribution to biology to Dr. Vidal, of Périgueux, for his memoir on the influence of chloroform on nutrition.

THE Lenval prize for an improvement in the treatment of deafness will be awarded at the International Otological Congress that will meet in London from the 8th to the 11th of August next.

THERE will be a Civil Service examination in the State of New York on May 27th for the position of Assistant in Dietary Experiments, Lunacy Commission, at a salary of \$100 per month. The duties are to assist in the experiments being conducted by Professor W. O. Atwater with a view to the establishment of scientifically correct rations and dietary for the State hospitals. The examinations will relate to the experience and training of candidates and their knowledge of and ability to conduct scientific experiments of the kind indicated.

THE French Chamber of Deputies has appointed a committee to take into consideration the application of the decimal system to the measurement of time. The Society of Geography at Toulouse began to agitate the question in 1893 and has been especially active in the matter. It may be remembered that the Convention which adopted the decimal system applied it to time and it was actually used by the French government in the year 1794.

THE more important departments of the Russian government have approved the reform of the Russian calendar urged by the St. Petersburg Astronomical Society, and will adopt at an early date the system followed by the rest of the civilized world.

THE International Bureau of Weights and Measures has been holding its sessions at Paris. Among the foreign delegates in attendance were Professors Michelson, from the United States; Cheney, from Great Britain; Tahlen, from Sweden; Blazema, from Italy; Hirsch, from Switzerland; Hepiter, from Austria; Foerster, from Germany, and Mendeljev, from Russia.

THE American Society of Mechanical Engineers is holding its spring meeting at Washington as we go to press. Rear-Admiral George W. Melville presides, and about 600 members have signified their intention of being present.

THE American Climatological Association holds its sixteenth annual meeting at the building of the Academy of Medicine, New York City, on May 9th, 10th and 11th.

THE American Library Association is meeting during the present week at Atlanta, Ga.

EXPERIMENTS were made recently at the South Foreland to demonstrate the possibilities of communicating between a moving ship and the land. According to the *London Times*, Signor Marconi joined the French commission on board the despatch vessel *Ibis*. The receiving and transmitting instruments on board the *Ibis* were in a cabin, the wire to take the current being connected with the instrument room from the top of the mast, about 150 feet high. The messages were transmitted to the *Ibis* from the South Foreland, from Wimereux, and from the East Goodwin lightship, as also from the gunboat to each of these points, and in each instance they were recorded with unerring distinctness, the French commissioners expressing the greatest satisfaction with the system. Hitherto one of the chief objections raised to wireless telegraphy has been that it is impossible to concentrate the current—in other words, to 'cut out' and prevent the message from being received at other stations where installations exist within an equal radius other than the one for which it was originally intended.

Signor Marconi has now discovered an ing but simple arrangement by which this difficulty can be overcome, and it was tested before a French commission and at the South Foreland. Messages were first sent from the *Ibis* to the South Foreland, and, as Professor Flourens pointed out on his recent visit, were received simultaneously by the Goodwin lightship. When Marconi's new invention was then tried, and the messages sent to the Foreland concentrated there and received at no point, the lightship being cut out. A series of experiments was made with the lightships communicating with each other, while the Foreland was cut out. As a further test of the important invention messages were sent simultaneously from Boulogne and the lightship to the South Foreland, where only the Boulogne message was taken by the receiver, the Foreland being cut out at will. This experiment was also tried on board the *Ibis* and from the points, in each instance with complete success.

REUTER'S Agency states that Dr. Sven Hedin will start from Stockholm at the end of June on a new expedition to Central Asia, and will travel direct through Russia and Turkestan to Kashgar, taking a new route over the Pamirs. Dr. Sven Hedin will conduct the expedition alone, being accompanied only by his Asiatic servant, Islam Bai, from Osh. He has received permission from the Czar to take Cossacks as escort. On reaching Kashgar Dr. Sven Hedin will proceed in an easterly direction for the purpose of making fresh investigations in Chinese Turkestan, where he hopes to find further antiquities. Thence he will visit the unexplored Lob Region, and will cross the Gobi Sand Desert by more than one route. After going to Tibet and exploring that portion of the country to the south of his former route, he will return *via* India. As in the case of his famous journey across Asia, Dr. Sven Hedin's objects on this expedition are purely scientific. The difficulties to be expected are of much the same character as those experienced during his former trip. Dr. Hedin is, however, better prepared than he was on that occasion, and hopes to achieve even better results than he did then. The expenses of the expedition, which

will amount to £2,000, have been defrayed by King Oscar, Mr. Emanuel Nobel and others.

THE Brussels Geographical Society has received the first report of Lieutenant Gerlache, commander of the Belgian Antarctic expedition. According to the London *Times* the report says that the expedition left St. John's Bay on January 14, 1898, and on the 21st explored the South Shetland Islands. On January 15th, in $55^{\circ} 5'$ south latitude and $65^{\circ} 19'$ west longitude, soundings to the depth of 4,040 mètres were taken. The *Belgica* left on the 23d for Hughes Bay, discovering a strait separating the lands of the east from an unknown archipelago. The land to the east was named Danco Land. Magnetic observations were made and interesting botanical, geological and photographic results were obtained. On February 18th the *Belgica* went in the direction of Alexander I. Land, exploring the belt of bank ice towards the west. On March 10th the ship became fast in the ice in latitude $71^{\circ} 34'$, longitude $89^{\circ} 10'$. The sun disappeared on May 17th, and there was continual night until July 21st. M. Danco died on June 5th, and his remains were deposited in a tomb of ice. The *Belgica*, after leaving her winter quarters, again became fast in the ice in 103° west longitude. She reached open water on March 14th. The expedition made successful magnetic and meteorological observations and obtained collections of pelagic and deep-sea fauna and samples of submarine sediments. On February 26th Black Island was explored, and on the following day the *Belgica* entered the Cockburn Channel, arriving at Punta Arenas, in Patagonia, on the 28th of last month.

THE ranchmen of Seward County, Kansas, says the *Electrical World*, have connected their ranches by telephone facilities, using the barbed-wire fences instead of setting poles and stringing wires. It had been demonstrated that a fence wire worked perfectly for a telephone connection. The scheme was favored by the stockmen, and a local company was formed, with headquarters at Liberal, that being the nearest telegraph point. Lines have been constructed and are in operation, extending from Liberal over the whole of Seward, Stevens and Morton Counties, Kansas, and have reached

out into Beaver County, Oklahoma, and Hansford County, Texas. Many of the ranches in this grazing country are situated miles from railroad and telegraph facilities.

THE first stone of the oceanographic museum at Monaco was laid on April 26th by the Bishop in the presence of Prince Albert, Princess Alice and the Crown Prince. Count Münster, on behalf of the Emperor William, spoke of the museum as a pledge of peace and amity among peoples, while Admiral Brown de Colstoun, on behalf of France, congratulated the Prince on his maritime researches. The Prince expressed his thanks to the German Emperor and President Loubet for sending representatives to the ceremony. As we stated recently, the museum has been founded by the Prince of Monaco for the exhibition and study of the collections made under his auspices.

A TELEGRAM has been received at the Harvard College Observatory from Professor J. E. Keeler at Lick Observatory, stating that comet Tempel was observed by Perrine, May 6, 9077 Greenwich mean time in R. A., $18^h 52^m 57^s.8$ and December $4^{\circ} 32' 19''$, Faint. This is an observation of comet Tempel, 1873 II., and not 1866 I., which is connected with the meteoric swarm of November 13th. An ephemeris was published by Schulhof in *Astron. Nach.*, Vol. 149, p. 23, which agrees within a few seconds of the position given above.

UNIVERSITY AND EDUCATIONAL NEWS.

THE great State Universities of the Central and Western States are continually growing in wealth and influence. During the present year the following additional endowments are reported: An appropriation bill recently passed by the Illinois Legislature gives to the University of Illinois about \$600,000. The Wisconsin Legislature has appropriated for the University of Wisconsin \$151,000, of which \$100,000 is for an engineering building. The Colorado Legislature, besides passing a bill giving its State University an income of one-fifth of a mill on each dollar of assessed valuation, has made appropriations amounting to about \$110,000. In Nebraska the State University has been

given a one-mill tax, which will, it is estimated, yield about \$168,000 yearly.

AT a meeting of the Board of Trustees of Columbia University on May 1st President Low announced that he would reimburse the University for the interest paid on money borrowed to complete the library. This will be about \$75,000, making his total gift for the building \$1,200,000. The offer of the Chamber of Commerce to give \$15,000 a year for a course in commerce was accepted.

COLUMBIA UNIVERSITY has recently received a gift of \$10,000, to be known as the Dyckman Fund for the Encouragement of Biological Research, the interest of which will be granted to post-graduate students. The fund is established by Mr. Isaac M. Dyckman in memory of his two uncles, Jacob and James Dyckman, of the classes of '10 and '11. The former of these, although dying when scarcely over thirty years of age, was a Fellow and Trustee of the College of Physicians and Surgeons, Health Commissioner of New York, and author of several works on medical and biological subjects. A second gift to the department of zoology is the continuance of the John D. Jones Scholarship, which was created by the Wawepex Society and includes a workplace in the Cold Spring Harbor Biological Station. A third gift is the collection of shells of Henry D. van Nostrand, which comes to the University through the generosity of his widow. This collection is well known among malacologists. It is particularly rich in pulmonates.

IN order that the scientific museum of Princeton University may have a complete collection of the quails of this country, Mr. W. E. D. Scott, curator of the museum, has sent out 800 circulars to members of the alumni, asking for a pair of quail from each locality. From the many favorable replies received it is probable that the entire number desired will be secured by the fall, making a collection especially valuable for studying the geographical variation of the bird. Excellent progress is being made in mounting representatives of the South American birds received from the Patagonian expedition. The entire expense of this collection is borne by John W. Garrett, of the class of 1895.

THE current issue of *Nature* gives an illustration of the proposed new buildings of the Royal College of Science, South Kensington. The British government has followed the advice of men of science and has decided to build the building on the west side of Exhibition Road, originally secured for that purpose by the Exhibition Commissioners of 1851.

THE state of affairs in the Russian universities is not improving, and practically all institutions for higher education in the Empire have been closed until the end of the present academic year. The expelled students have been scattered all over Russia, by which means it is supposed the police are doing the most in their power to spread discontent and possible revolution.

THE following table sent us from the University of Michigan shows the ratio of the teaching force to the number of students in ten of the largest universities of the country. The first column gives the number of persons comprising the faculty, including instructors of all grades; the second gives the total number of students enrolled in the institution; the third the ratio of students to teachers.

	Faculty.	Students.
Johns Hopkins.....	123	641
Cornell.....	328	2038
Columbia.....	303	2185
California.....	286	2391
Northwestern.....	222	2019
Harvard.....	411	3901
Yale.....	255	2500
Chicago.....	212	2307
Pennsylvania.....	258	2834
Michigan.....	222	3192
Total.....	2620	24008

DR. FRANZ BOAS, lecturer on physical anthropology in Columbia University, has been elected professor of anthropology in the same University. Dr. J. H. Canfield, President of the State University, has been elected librarian.

DR. MAX WIEN, of the University of Würzburg, has been appointed associate professor of physics in the Institute of Technology at Würzburg. Professor Schrepfer, of Cologne, has been appointed professor of mechanical and electrical engineering in the University of Würzburg.

SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; J. LE CONTE, Geology; W. M. DAVIS, Physiography; HENRY F. OSBORN, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; J. McKEEN CATTELL, Psychology; DANIEL G. BRINTON, J. W. POWELL, Anthropology.

FRIDAY, MAY 19, 1899.

CARL FRIEDRICH GAUSS AND HIS CHILDREN.

CONTENTS:

<i>Carl Friedrich Gauss and his Children</i> : PROFESSOR FLOBIAN CAJORI	697
<i>The Age of the Earth as an Abode fitted for Life (II.)</i> : LORD KELVIN.....	704
<i>Mental Fatigue</i> : DR. EDWARD THORNDIKE.....	712
<i>Scientific Books</i> :—	
<i>Patten on the Development of English Thought</i> : PROFESSOR R. M. WENLEY. <i>Peruvian Meteorology</i> : R. DEC. WARD. <i>Morgan on the Elements of Physical Chemistry</i> : PROFESSOR HARRY C. JONES. <i>Books Received</i>	713
<i>Scientific Journals and Articles</i>	718
<i>Societies and Academies</i> :—	
<i>The New York Academy of Sciences, Section of Biology</i> : DR. GARY N. CALKINS. <i>Section of Geology and Mineralogy</i> : ALEXIS A. JULIEN. <i>Geological Conference and Students' Club of Harvard University</i> : J. M. BOUTWELL. <i>The Academy of Science of St. Louis</i> : PROFESSOR WILLIAM TRELEASE. <i>University of Colorado Scientific Society</i> : DR. FRANCIS RAMALY.....	718
<i>Discussion and Correspondence</i> :—	
<i>The Storage of Pamphlets</i> : F. A. BATHER.....	720
<i>The Marine Biological Laboratory at Wood's Holl</i> ..	721
<i>Geological Expedition of Dr. Becker to the Philippines</i> : W. F. M.....	722
<i>Conversations of the Royal Society</i>	723
<i>Scientific Notes and News</i>	724
<i>University and Educational News</i>	728

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

THE life of Carl Friedrich Gauss has been sketched repeatedly, yet, in view of the interest attached to every bit of new information concerning men of genius, we venture to touch upon a few events of his later life and to speak of his descendants.

The 16th of July, 1899, will be the 100th anniversary of Gauss's graduation with the degree of Doctor of Philosophy. The 50th anniversary was a day of celebration at Göttingen. Gauss was still in full possession of his powers and was greatly admired and beloved. His daughter Theresa describes the memorable day in a letter, dated December 5, 1850, and written to her brother Eugene in St. Charles, Mo. In translation the passage is as follows:

"I cannot tell you much of our quiet life; one day and one year is always very much like every other. But they are contented days and years, as father even now in his advanced age still possesses unimpaired health and an always cheerful disposition. A year and a half ago, in July, '49, he celebrated his '50-jähriges Doctorjubiläum'—or rather the University and the city celebrated it for him with general love and sympathy. He himself was very much opposed to having this day noticed, but, without his knowledge, everything had been prepared for it. From near and far the University had invited strangers; father's friends and eminent scholars came, many delegations from other cities, who brought him congratulations, honorary doctor's diplomas and three new orders. From Braunschweig and Göttingen he received honorary citizenship; from the King, con-

gratulations in his own handwriting and a higher order (erhöhten Ordensgrad). There was no end of letters and communications. In the morning festive processions began to congratulate him, all the authorities of the city, of the University, of the school, strangers, acquaintances—probably about fifty persons. Then father himself delivered a lecture in the hall of the University, which was overcrowded with spectators and listeners and had been decorated with garlands and flowers like a fairy hall. Even the houses in the streets were decorated with flowers; in the city there were waves of people in festive attire (*wogte es von geputzten Menschen*), as on a holiday. When, at last, in the evening at seven, father came home from the great banquet, he was, indeed, quite exhausted, and it was well that the torchlight procession that the students had intended for him was abandoned upon his wish, but the love and sympathy which had been shown him from all sides had, in spite of all fatigue, pleased him indescribably. How sad was it though that, where so many strangers had congregated on his day of honor, not one of his beloved sons could be with him!! Even Joseph had been compelled to decline, as his position as railway director did not, at that time, make his absence from Hannover possible."

Gauss was married twice. By his first wife he had two sons (Joseph and Louis) and one daughter (Minna). Louis died in childhood. By his second wife he had two sons (Eugene and Wilhelm) and one daughter (Theresa). Eugene and Wilhelm settled in the United States. In Germany Gauss has only one grandchild, Carl Gauss, now living at Hameln, in Hannover. He is a son of Joseph. He was only six years old when his grandfather died, in 1855. He still remembers how his celebrated grandfather tried to show him a star through the great telescope; how he stood full of expectation near the ocular, while his grandfather, wearing a velvet cap, was turning the crank which moved the shutter on the dome of the observatory. Another time the child was playing in the garden of the observatory when his grandfather met him and asked: "What do you expect to make of yourself?" whereupon young Carl replied: "Well, what do you expect to make of yourself?" Then the old man patted the

child's shoulder and said smilingly boy, I am already somebody."

In a letter addressed to the writer Gauss speaks also of his father, Joseph, who, after completing the gymnasi in Göttingen, went into the German army but subsequently got leave to assist his father in the triangulation of the Kingdom of Hannover. When the construction of railways was first begun in that part of Germany officers of the army were selected, along with some foreign experts, to superintend the work. So it happened that Joseph Gauss left the army and served as an engineer. In 1836 and '37 he was sent by his government to the United States to study the more advanced methods of railway construction in the New World. There he became 'Oberbaurath' and directed the construction of railroads and telegraphs in Hannover. Finally he was assigned to the superintendence of the special department of telegraphs, which position he kept until the outbreak of the war of 1866. It is of great interest to think of him in connection with the telegraph—the instrument in the invention of which his father had played an important rôle. It is well known that as early as 1833 C. F. Gauss and W. Weber had a telegraphic line between the observatory and the physical cabinet in Göttingen.

Some biographers assert that Gauss's favorite child was Joseph, but there is no reason to believe that the father at first had high hopes on what Eugene would do. In a letter to Bessel (November 21, 1828) after writing about hypergeometric and logarithmic series, he says: "Wenn meine Kinder des Vaters Liebe zu den exacten Wissenschaften erben sollte, so wahrscheinlich eher dieser Eugen als leichtblütiger Bruder Joseph." As the infant reached boyhood he displayed far more than ordinary ability, especially in languages. His father once took a F

book, examined him in the knowledge of French, and then said that he knew that language well enough and need not study it any further. Another time Gauss took the boy from Göttingen to a little town called Celle, to place him at a school. While stopping at an inn Eugene stated to his father his delight in having solved some little problem in grammar. His father, with eyes brightened with pleasure, replied: "Yes my son, the pleasure one gets from the solution of such problems is very great, but it is not to be compared with the similar pleasure one derives from the solution of mathematical problems."

But the high hopes were followed by bitter disappointment. In a letter to Bessel (Dec. 31, 1831) Gauss says of himself: "Aber Ihr armer Freund ist seit andert-halb Jahren das Opfer der schwersten häus-lichen Leiden gewesen: den Ausgang des einen ahnen Sie leicht aus der seit vier Monaten gebrauchten Farbe des Siegels; von einem andern, wo möglich noch härtern sehe ich kaum ein Ende ab als meines. Lassen Sie mich davonschweigen. Lähmend haben solche Verhältnisse auf alle meine wissenschaftlichen Beschäftigungen, fast ganz aufhebend auf meine Correspondenz eingewirkt." The first sorrow alluded to was clearly the death of his second wife; the cause of the second sorrow he leaves un-explained, but the facts which we have been able to gather concerning the relation between him and his son Eugene throw light on this point. At this time, when Eugene reached adolescence, it seems that Gauss did not want him or his brothers to attempt mathematics, for the father did not think any of them would surpass him, and he did not wish the name lowered. Ap-parently he felt the same way about any other line of scientific work, for, while Eugene, after completing the gymnasium, desired to make the study of philology his life-work, the father wanted him to take up

law. At this time Eugene was disposed to indulge in the wild life of a Göttingen stu-dent. A scar on his face bore witness of his participation in a duel. What that life was we may judge also from the accounts of Bismarck's stormy career at Göttingen, which began about a year after Eugene left the University. An incident happened which resulted in a serious disagreement between father and son. Eugene gave an elaborate supper to his fellow-students and sent the bill to his father. When the latter re-proached his son for this, Eugene suddenly concluded that he would leave Germany and come to America. He started off with-out bidding the family good-bye or making any preparation for his journey. When Gauss learned of his son's intention he fol-lowed and urged him to return, at the same time telling him that he had brought his trunk and if he was determined to seek his fortune in America he would furnish funds for the journey. The son refused to return home, and the two parted. The young man of nineteen left the land of learning and culture, to expose himself to the dangers and temptations of a new world. Need we marvel if, in sorrow and humiliation, Gauss wrote to Bessel: 'Lassen Sie mich davon schweigen.'

Eugene landed in New York and, after spending what money he had, enlisted as a private in the U. S. army. He was taken to Fort Snelling, near St. Paul, Minn. The post was in charge of General Taylor, and Jefferson Davis was a young officer there. By accident the officers found out that Eu-gene Gauss was an educated man, and he was put in charge of the post library. About the close of his term of enlistment (five years) his brother Joseph came to this country, as we have seen, to study rail-way construction. Joseph brought letters to General Winfield Scott and thought he could obtain for Eugene a commission in the regular army, if he desired it. But

Eugene had other plans; he entered the employ of the American Fur Company, on the head waters of the Mississippi and Missouri Rivers. There he learned to speak the Sioux language with ease, and assisted a missionary named Pond in preparing a Sioux alphabet. While there Eugene wrote to his father that he had met the French astronomer Nicollet. The latter was attracted to young Gauss by hearing someone pronounce his name and, upon inquiry, discovered that he was the son of the mathematician. Nicollet formed a plan to conduct an expedition across the continent to the Pacific, where he expected to take ship and go by water to Europe. Eugene was to go with him, but the enterprise was defeated by Nicollet's death. In the first letter printed below, Gauss refers to Nicollet and attributes to him a sensational article on moon hoax, which appeared in 1835 in the *New York Sun*. It purported to be written by Richard Adams Locke, but De Morgan, in his 'Budget of Paradoxes,' holds, as does Gauss, that its real author was J. N. Nicollet.

About 1840 Eugene settled at St. Charles, Mo., where he resided until about 1885, when he removed to a farm in Boone County, Mo., near Columbia. He died in 1896. In St. Charles Eugene engaged in mercantile pursuits. In 1844 he married Henrietta Fawcett, who is still living, being now in her 82d year. They had seven children, two of whom have died. Of interest is the following letter written by the mathematician Gauss, to his son, just before the latter's marriage:

"MEIN LIEBER SOHN:

Die in Deinen beiden Briefen an mich und Theresen enthaltene Anzeige von Deiner beschlossenen und nahe bevorstehenden Verheirathung habe ich in mehreren Beziehungen mit Vergnügen aufgenommen. Bei der Unmöglichkeit, über Verhältnisse und Personen aus eigener Kenntniss ein Urtheil zu bilden, überlasse ich mich gerne dem Vertrauen, dass Dein Alter und Deine Erfahrungen, Dich vor solchen Täuschungen, in

welche wohl unbesonnene und unerfahrene Jünglinge verfallen, bewahren. Ich wünsche und hoffe herzlich, dass alle die schönen Tugenden, welche von Deiner künftigen Lebensgefährtin rühmend die den Mangel äusserer Glücksgüter für ein ständigen und auf eigenen Füßen feststehender fühlenden Mann wohl aufwiegen, sich stets bewähren werden, zugleich aber auch, dass Du des Besitzes eines solchen Schatzes immer würdigen wirst, und dass so die Verbindung zwischen beider wahrem Glück gereiche.

Auch Deine beiden Brüder haben sich Lebensgenossen ohne Vermögen gewählt. Dass Du das auch mit so vieler Leichtmüthigkeit hinweg ist mir auch in sofern angenehm, als ich dari Bestätigung von dem voraussetze, was Herr vor einigen Monaten hier äusserte, nemlich Deine Umstände und Handelsgeschäfte in einer perirenden Zustande sind. Hr. Eggers Bescheid übrigens so kurz, dass ich über so vieles was ich näher wüsste, nur sehr unvollkommene oder gar Kenntniss erhalten habe. So weiss ich namentlich Deinem Geschäfte bloss im Allgemeinen, dass Kaufmännisches sei, und dass Du mit einem Compagnon associirt seiest; näheres aber z. B. von Art jene Geschäfte, ob der Compagnon ein Deutscher oder ein Amerikaner sei &c. habe ich nicht erfahren.

In einem Deiner früheren Briefe erwähnst Du einmal eines jungen Franzosen Namens Nicolle dem Du in Bekanntschaft gekommen seiest. Du war vor Zeiten Gehülfe an der Pariser Sternwarte hat einige nicht verdienstlose Arbeiten geliefert welchem Grunde er Frankreich hat verlassen habe ich nicht erfahren.* Später (etwa vor 7 Jahren) hat er (ich weiss nicht mehr ob anonym mit Nennung des Namens) in einer Amerikanischen Zeitung oder Journal einen posse-reisnerischen Artikel über angebliche wahrhaft unsinnige Entdeckungen, die Herschel auf dem Vorgebirge der guten Hoffnung gemacht haben sollte, geliefert. Dieser Artikel wurde sogar seiner Zeit ins Deutsche übersetzt und gab einen merkwürdigen Beweis, wie sehr eine Mystification sein kann, ohne die Kraft zu verlieren, viele Leute zu Narren zu machen. Dieser Artikel soll vor Kurzem in Amerika gestorben sein. Ich möchte wohl wünschen, über seinen dortigen Lebenslauf etwas mehr zu erfahren. Auch ein Astronom, aus der Schweiz gebürtig, aber seit 1

* Laplace once recommended Nicollet for membership in the French Academy, but he failed of election because of Arago's opposition. "A short time afterwards M. Nicollet had run away to America, as the Bureau of Longitude had a warrant passed to him ignominiously from its bosom."—From *An Autobiography*.

Jahren, in Amerika einheimisch geworden, mit dem ich wohl, von Zeit zu Zeit einige Korrespondenz gepflogen habe, nemlich Rudolf Hassler, Chef der Amerikanischen Messungen, ist, wie ich aus öffentlichen Nachrichten erfahre, vor kurzem gestorben.

Unter den herzlichsten Wünschen für das dauernde Glück Eurer Verbindung

Dein treuer Vater

C. F. GAUSS.

GÖTTINGEN, 15 Februar, 1848.

P. S. Briefe über Liverpool gehen weder sicherer noch schneller als über Havre, kosten aber hier jedesmal ein enormes Porto, etwa 3 mal so viel wie über Havre. Schicke daher künftig keine Briefe über England sondern immer via Havre.

The correspondence between Gauss and Hassler, the organizer and first superintendent of the U. S. Coast Survey, would be of interest, no doubt, but none of the letters are in possession either of the U. S. Coast Survey or of Mrs. Simon Newcomb, who is a grandchild of Hassler.

The original of Gauss's letter, given above, is now in the Lick Observatory. The present writer has a photograph of it. A strange thing in connection with it is the fact that Gauss, who possessed such wonderful power over numbers as to create a new Theory of Numbers, should make a mistake in so simple a matter as a date. The number '1848' should be '1844.' This is evident from the postmark on the back of the letter as well as from Theresa's letters and from the record of the marriage of Eugene, contained in the office of the Recorder of St. Charles County, where the marriage took place.

Another letter from Gauss to Eugene is now in the possession of a grandchild, Charles Henry Gauss, of Columbia, Mo. It is as follows:

LIEBER EUGEN:

Ich kann nicht unterlassen, Deinen vom 16 Mai datirten und am 30 Junius hier eingegangenen Brief wenigstens mit einigen Zeilen zu erwiedern, obwohl ich aus zwei Ursachen zur Kürze gezwungen werde, nemlich, erstlich, weil Therese wegen Absendung des Pakets pressirt ist, und zweitens, weil ich ziemlich unwohl bin, und den grössern Theil des Tages auf

dem Sofa liegend zubringen muss. Grossentheils mag dies die Folge der unerträglichen Hitze sein, bei der ich immer sehr leide, und die in diesem Sommer grösser ist, als ich je in meinem ganzen Leben erduldet zu haben mich erinnere. Nach den öffentlichen Blättern scheint diese Hitze in Europa ganz allgemein zu sein.

Dass ich nun auch von Deiner Seite in der Neuen Welt einen Enkel habe, ist mir sehr erfreulich; in der Alten Welt wird mein Name wohl aussterben, da Josephs Ehe schon ins siebente Jahr kinderlos geblieben ist. Aller Wahrscheinlichkeit wird Joseph nun mit Nächstem in eine veränderte Lage kommen, ihm selbst mehr zusagend, als eine Lieutenanstelle in Friedenszeit, und mir selbst auch aus dem Grunde lieb, weil er räumlich mir näher kommt. Er ist nemlich bestimmt, mit in unser Eisenbahn-*Directorium* einzutreten, wobei er seinen Abschied aus dem Militär und sein gewöhnliches *Domicilium* in Hannover wird nehmen müssen, obwohl er dabei während eines grossen Theils des Jahres auf Reisen zuzubringen haben wird. Er ist in diesem Augenblick in Stade, um seine Frau nach Hannover abzuholen.

Dass Deine Geschäfte gut prosperiren freut mich sehr, aber in einem neulich von Deiner Grossmutter erhaltenen Briefe ist eine etwas unverständliche Andeutung, als ob Du gewillet seiest, jene aufzugeben auf das Land zu ziehen, und von da aus bloss Grosshandel zu treiben. Da in Deinem Briefe an mich darüber gar Nichts vorkommt, so vermute ich, dass jene Äusserung wenigstens zum Theil auf einem Misverständnisse beruhet. Übrigens haben wir vor Kurzem ein tangibles Zeichen Deiner Geschäftthätigkeit erhalten, da Herr Westhof uns ein Fässchen Mehl aus der Mühle Gauss & Weidner zugeschockt hat, welches Therese sehr lobt, als besser, wie alles hiesige.

Zufällig hatten wir gleichzeitig einen Topf Butter aus dem Altenlande von Josephs Frau erhalten, und es fehlten also zu einer Omelette abseiten meiner Kinder aus fremden Landen nur noch die Eier aus Wilhelms Hühnerställe.

Ueber das Daguerrebild, welches Deine liebe Frau Therese geschickt hat, haben wir uns sehr gefreut; die Arbeit ist feiner, als ich sie an einem in Europa gemachten Daguerrebilde sonst gesehen habe. Therese erwiedert es mit ihrem Daguerrebild, welches in zwei Exemplaren, eines für Dich, eines für Wilhelm Herr Angetrodt mitbringt. Ausserdem und zu gleicher Distribution bringt er zwei Lithographien von meinem Portrait mit; sie sind im vorigen Winter von einem Oelgemälde abgenommen, welches vor 6 Jahren hier gemacht ist. (Das Original dieses Oelgemäldes von einem Kopenhagener Künstler kam nach

Petersburg, und eine Copie für Herrn Sartorius blieb hier, wonach jene Lithographie gemacht ist. Man fand das Gemälde damals sehr ähnlich; jetzt werde ich ihm wohl unähnlich geworden sein.

Auch für die Karte von Missouri und Arkansas, welche mit jenem Bilde zugleich ankam, habe ich Dir noch zu danken.

Dass Ewald noch im vorigen Jahre sich wieder verheirathet hat, wird Dir wahrscheinlich die Grossmutter geschrieben haben. Mit herzlichen Wünschen für Dein Wohlergehen

Dein treuer Vater,
C. F. GAUSS.

GÖTTINGEN,
den 9ten August, 1846.

An account of Gauss's children is interesting from the standpoint of heredity. None inherited Gauss's mathematical power. Eugene resembled his father mentally more than the others. Like his father, he possessed great linguistic powers. Before his death he expressed it as his opinion—and from all I can gather it is probable—that had he continued his philological studies in Germany he would have secured a chair in a University. He spoke French so well that he was taken for a Frenchman. The English and the Sioux language he spoke to perfection. He read the New Testament in the original. At the age of forty he had become deeply interested in religion, and thereafter he gave much attention to Biblical and theological reading. His deep religious convictions were shown by his expression of satisfaction with his coming to America, because if he had not done so he might never have been led to profess the religion of Christ.

Eugene was not the person to push himself to the front. He lived over ten years near the seat of the University of Missouri, without seeking the acquaintance of any member of the Faculty. Milton Updegraff, the professor of astronomy, accidentally heard of him through one of his students and visited him (about 1890). He told Professor Updegraff that his father first thought of the heliotrope while walking with him and noticing the light of the

setting sun reflected from a window distant house.* Eugene possessed mathematical ability, but he never studied higher branches. When he was over 60 years old and had become blind, he used to entertain himself by making long arithmetical calculations in his head. For instance, he computed the amount to which one dollar would grow, if compounded annually at a rate of 4% interest from the time of Adam to the present, assuming this to be 6,000 years. This, if in gold, would make a cubic mile so large that it would require light centuries of millions of years to pass along one side of it. This mental computation is so startling to be almost beyond belief. The only assistance he had was from his son Theodore (now deceased), who was asked to write down, at intervals during the several years he was so occupied, the results that marked the different stages of his work. Eugene arrived at his result by ordinary arithmetic. His son preserved the paper on which he had written the long lines of figures which he thought he might not be able to retain in his memory. On the sheet are several memoranda that are interesting. For instance, Eugene directed his son to write down the figures:

```
123456789057182178039
                      3680824926969613857
-----
123456789060863002965969613857
                      X
```

The second line of figures was written down several days after the first and added to the upper one by Theodore. His father had directed him to begin the second line of figures by placing the figure 3 under the second 7 of the upper line. In reading the result of this addition Theodore read 5 in place of the 8 marked with an X. Eugene detected the error and his son made

* See also Bessel's letter to Gauss, Oct. 18, 1821.

† The answer exceeds five quadrillions of years in French numeration.

correction, showing that the blind and aged man was able to retain in his mind the long line of thirty figures. This wonderful computation, if it does not demonstrate great mathematical ability, certainly shows an extraordinary memory. We involuntarily ask: What might Eugene not have achieved, had his experiences in life been such as to draw out his faculties to the fullest extent?

Eugene's younger brother Wilhelm came to this country in 1837, immediately after his marriage to a niece on the mother's side to the astronomer Bessel. Wilhelm wished to make farming his vocation and he believed the opportunities were better in the United States than in Germany. For twenty years he was almost continually engaged in farming in Missouri; then he entered the wholesale shoe business in St. Louis, in which he continued until his death, in 1879. Of his eight children six are now living; some are in business; two are Presbyterian clergymen.

Near the beginning of this article we quoted from a letter, written by Theresa to her brother Eugene. I have seen another of her letters (dated May 16, 1855), in which she gives an account of the last illness of her illustrious father. From the long letter we translate the following:

"The last year of suffering—full of sickness demanding constant attendance—has bound me still more closely to him. During the last weeks there was hardly a moment, day or night, when he permitted me to be away from him, and he expressed the desire that we might not be separated even by death, for only a few days before he died he said to me: 'The best and greatest that God could grant us would be this one favor, that we two on the same day might die together.' * * *

"My last letter to you, dated, I believe, April 30, '53, is two years old, and if at that time I wrote that father's health was no longer quite robust, it nevertheless did not cause any unusual anxiety. But in the course of the summer following he began to complain to such an extent as to cause alarm. Part of the time he suffered much, and, his strength failing rapidly, I, full of apprehension, besought him in vain

to call in a physician. Not till January, 1854, as the disease in a few weeks had made rapid progress, did he consent. The physician, who has since with unremitting love, care and sympathy attended him, lessened his suffering where cure was impossible, and doubtless somewhat prolonged his life, declared to me positively, after the first visit, that his condition was dangerous and hopeless. He recognized the disease at once as a heart trouble, which probably had been coming on for years, in course of which there had been an accumulation of water about the heart, which in a few weeks also extended to other parts of the body. At that time the disease advanced rapidly and left little hope, but under the careful treatment of our loving physician, Dr. Baum, some improvement followed like a miracle. Some symptoms of the disease disappeared entirely, and father was able to go out for short distances, though only slowly and with immediate exhaustion. * * * But suddenly in November the old trouble returned in more decisive form, increased from day to day, and at the beginning of the present year the physician said to me the life of our beloved one would be of only short duration. The last weeks of suffering were terrible, as the disease of dropsy in general is terrible, because it visibly approaches death inch by inch. But father has borne all his suffering to the end with unvarying, touching serenity, friendliness and patience. Entirely hopeless he never was; he always believed in the possibility of recovery so long as one spoke encouragingly to him. Ah! how difficult this has often been, when I, hopeless, knew the nearness of death! He never lost complete consciousness. Four hours before his death he still knew me, when, for the last time, he took a drink from my hand, drew my hand toward him and, kissing it, looked lovingly at me. He then closed his eyes and seemed to sleep, but I believe he did not sleep, but that his spirit, clear and conscious as ever, had freed itself from its earthly shell and had gone to its heavenly home."

We close with a letter written to Eugene Gauss by Professor Ernst Schering, C. F. Gauss's successor at the observatory in Göttingen, who himself has since joined the ranks of the departed:

STERNWARTE, GÖTTINGEN, 1892, Nov. 21.

SEHR GEHRTER HERR GAUSS:

Wie Sie aus beifolgendem Correcturbogen ersehen werden, sind wir hier in Göttingen im Begriffe ein Denkmal für Ihren berühmten Vater zu errichten. In der Meinung, dass Sie wünschen werden, Ihren Namen in der Aufforderung der Mathematiker, As-

tronomer und Physiker gedruckt zu sehen, habe ich, als Nachfolger Ihres Vaters, jetzt in seiner Dienstwohnung befindlich, und als Herausgeber seiner grossen Werke, mir erlaubt Ihren Namen mit in die Liste einsetzen zu lassen. Es war nicht mehr Zeit Sie um Ihre Erlaubnis dazu zu fragen, aber es kann bei mir kein Zweifel sein über Ihre Genehmigung. Gerne werde ich mir erlauben, Ihnen weiteren Bericht über die Denkmalsfrage abzustatten, so bald etwas definitives feststeht.

Der Prinz Albrecht von Preussen, Prinz Regent vom Herzogthum Braunschweig, Rector Magnificientissimus von der Universität Göttingen, hat sich bereit finden lassen, das Protectorat der Commission für das Denkmal zu übernehmen. Er hat befohlen, dass aus Landesmitteln des Herzogthums Braunschweig 3000 Mk. für das Denkmal gegeben werden. Das ist ja ein sehr guter Anfang. In den Zeitungen habe ich die Notiz gelesen :

Gauss, E. F. L. erster Assistent von Frederik H. Hild dem Librarian of the Chicago Public Library. Gehört dieser Gauss auch zu der berühmten Familie?*

Da das Deutsche Reich sich auch amtlich an der grossen Ausstellung in Chicago betheiligt, so wird wahrscheinlich das Post- und Telegraphen-Museum in Berlin unter dem Reichssekretair von Stephan auch die Hauptstücke seiner geschichtlichen Sammlung dorthin senden. Darunter findet sich ein Gemälde von dem grossen Gauss und eine Reproduktion seines ersten Telegraphen. Jenes Gemälde ist Gauss sehr ähnlich, aber noch schöner finde ich das Gemälde, welches sich hier in seinem Erdmagnetischen Observatorium unter meinem Gewahrsam befindet. Es ist von der Preussischen Regierung zum 150 jährigen Jubiläum der Universität Göttingen 1887 dem Institute geschenkt worden. Ueberhaupt war dieses Jubiläum ein grossartiges Fest zur Verherrlichung von Gauss. Keine der vielen Tischreden, keine Festrede, keine Predigt wurde gehalten, ohne dass sein Name genannt und seine Erfindung des Elektrischen Telegraphen erwähnt worden wäre. Seit jener Zeit befindet sich auch seine Marmortafel an der Sternwarte, Abtheilung des Erdmagnetischen Observatorium, mit der Aufschrift

Erster electrischer Telegraph
GAUSS—WEBER
Ostern, 1833

* Mr. Robert Gauss, a son of Eugene Gauss and now managing editor of the *Denver Republican*, informs me that the E. F. L. Gauss in question is not a descendant of Gauss the mathematician. Schering's letter is in the possession of Robert Gauss, through whose kindness the writer was permitted to make a copy of it.

Mit den ergebensten Empfehlungen zeichne ich Ihr
ERNST SCHERING,
Herausgeber der Gauss'schen Werke. Gemein-
u. Professor.

FLORIAN CAJON
COLORADO COLLEGE, COLORADO SPRINGS.

THE AGE OF THE EARTH AS AN ABOI FITTED FOR LIFE.

II.

PROBABLE ORIGIN OF GRANITE.

§ 26. UPON the suppositions we have hitherto made we have, at the stage reached, all round the earth at the same time a red-hot or white-hot surface of granules or crystals with interstices filled by the mother liquor still liquid, but ready to freeze with the slightest cooling. The thermal conductivity of this heterogeneous mass, even before the freezing of the liquid part, is probably nearly the same as that of ordinary solid granite or basalt at a high heat, which is almost certainly* somewhat less than the thermal conductivity of igneous rocks at ordinary temperatures. If you wish to see for yourselves how quickly it would cool when wholly solidified take a large macadamizing stone, as hot as heat it red hot in an ordinary coal fire. Take it out with a pair of tongs and lay it on the hearth, or on a stone slab at a distance from the fire, and you will see that in a minute or two, or perhaps in less than a minute, it cools to below red heat.

§ 27. Half an hour† after solidification reached up to the surface in any part of the earth, the mother liquor among the granules must have frozen to a depth of several centimeters below the surface and must have cemented together the granules and crystals, and so formed a crust of primeval granite, comparatively cool at its upper surface, and red hot to white hot, but still

* Proc. R. S., May 30, 1895.

† Witness the rapid cooling of lava running red hot or white hot from a volcano, and after a few days or weeks presenting a black, hard crust strong enough and cool enough to be walked over with impunity.

all solid, a little distance down; becoming thicker and thicker very rapidly at first; and after a few weeks certainly cold enough at its outer surface to be touched by the hand.

PROBABLE ORIGIN OF BASALTIC ROCK.*

§ 28. We have hitherto left, without much consideration, the mother liquor among the crystalline granules at all depths below the bottom of our shoaling lava ocean. It was probably this interstitial mother liquor that was destined to form the basaltic rock of future geological time. Whatever be the shapes and sizes of the solid granules when first falling to the bottom, they must have lain in loose heaps with a somewhat large proportion of space occupied by liquid among them. But, at considerable distances down in the heap, the weight of the superincumbent granules must tend to crush corners and edges into fine powder. If the snow shower had taken place in air we may feel pretty sure (even with the slight knowledge which we have of the hardnesses of the crystals of feldspar, mica and hornblende, and of the solid granules of quartz) that, at a depth of 10 kilometers, enough of matter from the corners and edges of the granules of different kinds, would have been crushed into powder of various degrees of fineness, to leave an exceedingly small proportionate volume of air in the interstices between the solid fragments. But in reality the effective weight of each solid particle, buoyed as it was by hydrostatic pressure of a liquid less dense than itself by not more than 20 or 15 or 10 per cent., cannot have been more than from about one-fifth to one-tenth of its weight in air, and therefore the same degree of crushing effect as would have been experienced at 10 kilometers with air in the interstices, must have been

experienced only at depths of from 50 to 100 kilometers below the bottom of the lava ocean.

§ 29. A result of this tremendous crushing together of the solid granules must have been to press out the liquid from among them, as water from a sponge, and cause it to pass upwards through the less and less closely packed heaps of solid particles, and out into the lava ocean above the heap. But, on account of the great resistance against the liquid permeating upwards 30 or 40 kilometers through interstices among the solid granules, this process must have gone on somewhat slowly; and, during all the time of the shoaling of the lava ocean, there may have been a considerable proportion of the whole volume occupied by the mother liquor among the solid granules, down to even as low as 50 or 100 kilometers below the top of the heap, or bottom of the ocean, at each instant. When consolidation reached the surface, the oozing upwards of the mother liquor must have been still going on to some degree. Thus, probably for a few years after the first consolidation at the surface, not probably for as long as one hundred years, the settlement of the solid structure by mere mechanical crushing of the corners and edges of solid granules, may have continued to cause the oozing upwards of mother liquor to the surface through cracks in the first formed granite crust and through fresh cracks in basaltic crust subsequently formed above it.

LEIBNITZ'S CONSISTENTIOR STATUS.

§ 30. When this oozing everywhere through fine cracks in the surface ceases, we have reached Leibnitz's *consistentior status*; beginning with the surface cool and permanently solid and the temperature increasing to 1150° C. at 25 or 50 or 100 meters below the surface.

*See Addendum at end of Lecture.

PROBABLE ORIGIN OF CONTINENTS AND OCEAN
DEPTHS OF THE EARTH.

§ 31. If the shoaling of the lava ocean up to the surface had taken place everywhere at the same time, the whole surface of the consistent solid would be the dead level of the liquid lava all round, just before its depth became zero. On this supposition there seems no possibility that our present-day continents could have risen to their present heights, and that the surface of the solid in its other parts could have sunk down to their present ocean depths, during the twenty or twenty-five million years which may have passed since the *consistentior status* began or during any time however long. Rejecting the extremely improbable hypothesis that the continents were built up of meteoric matter tossed from without, upon the already solidified earth, we have no other possible alternative than that they are due to heterogeneousness in different parts of the liquid which constituted the earth before its solidification. The hydrostatic equilibrium of the rotating liquid involved only homogeneousness in respect to density over every level surface (that is to say, surface perpendicular to the resultant of gravity and centrifugal force); it required no homogeneousness in respect to chemical composition. Considering the almost certain truth that the earth was built up of meteorites falling together, we may follow in imagination the whole process of shrinking from gaseous nebula to liquid larva and metals, and solidification of liquid from central regions outwards, without finding any thorough mixing up of different ingredients, coming together from different directions of space—any mixing up so thorough as to produce even approximately chemical homogeneousness throughout every layer of equal density. Thus we have no difficulty in understanding how even the gaseous nebula, which at one time constituted the

matter of our present earth, had in itself heterogeneousness from which followed dynamical necessity Europe, Asia, Africa, America, Australia, Greenland and Antarctic Continent, and the Pacific, Atlantic, Indian and Arctic Ocean depths, we know them at present.

§ 32. We may reasonably believe that a very slight degree of chemical heterogeneousness could cause great differences in the heaviness of the snow shower of granules and crystals on different regions of the bottom of the lava ocean when still 50 or 100 kilometers deep. Thus we can quite easily see how it may have shoaled much more rapidly in some places than in others. It is also interesting to consider that the solid granules, falling on the bottom, may have been largely disturbed, blown as it were into ridges (like rippled sand in the bed of a flowing stream, or like dry sand blown into sand-hills by wind) by the eastward horizontal motion which liquid descending in the equatorial regions must acquire relatively to the bottom, in virtue of the earth's rotation. It is, indeed, not improbable that this influence may have been largely effective in producing the general configuration of the great ridges of the Andes and Rocky Mountains and of the West Coasts of Europe and Africa. It seems, however, certain that the main determining cause of the continents and ocean-depths was chemical differences, perhaps very slight differences, of the material in different parts of the great lava ocean before consolidation.

§ 33. To fix our ideas let us now suppose that over some great areas such as those which have since become Asia, Europe, Africa, Australia and America, the lava ocean had silted up to its surface, while in other parts there still were depths ranging down to 40 kilometers at the deepest. In a very short time, say about twelve years according to our former estimate (§ 24), the

whole lava ocean becomes silted up to its surface.

§ 34. We have not time enough at present to think out all the complicated actions, hydrostatic and thermodynamic, which must accompany, and follow after, the cooling of the lava ocean surrounding our ideal primitive continent. By a hurried view, however, of the affair we see that in virtue of, let us say, 15 per cent. shrinkage by freezing, the level of the liquid must, at its greatest supposed depth, sink six kilometers relatively to the continents, and thus the liquid must recede from them, and their bounding coast-lines must become enlarged. And just as water runs out of a sandbank, drying when the sea recedes from it on a falling tide, so rivulets of the mother liquor must run out from the edges of the continents into the receding lava ocean. But, unlike sandbanks of incoherent sand permeated by water remaining liquid, our uncovered banks of white-hot solid crystals, with interstices full of the mother liquor, will, within a few hours of being uncovered, become crusted into hard rock by cooling at the surface, and freezing of the liquor, at a temperature somewhat lower than the melting temperatures of any of the crystals previously formed. The thickness of the wholly solidified crust grows at first with extreme rapidity, so that in the course of three or four days it may come to be as much as a meter. At the end of a year it may be as much as ten meters; with a surface, almost, or quite, cool enough for some kinds of vegetation. In the course of the first few weeks the régime of conduction of heat outwards becomes such that the thickness of the wholly solid crust, as long as it remains undisturbed, increases as the square root of the time; so that in 100 years it becomes 10 times, in 25 million years 5,000 times, as thick as it was at the end of one year; thus, from one year to 25

million years after the time of surface freezing, the thickness of the wholly solid crust might grow from 10 meters to 50 kilometers. These definite numbers are given merely as an illustration, but it is probable that they are not enormously far from the truth in respect to what has happened under some of the least disturbed parts of the earth's surface.

§ 35. We have now reached the condition described above in § 30, with only this difference, that instead of the upper surface of the whole solidified crust being level we have in virtue of the assumptions of §§ 33, 34, inequalities of 6 kilometers from highest to lowest levels, or as much more than 6 kilometers as we please to assume it.

§ 36. There must still be a small, but important, proportion of mother liquor in the interstices between the closely packed uncooled crystals below the wholly solidified crust. This liquor, differing in chemical constitution from the crystals, has its freezing-point somewhat lower, perhaps very largely lower, than the lowest of their melting-points. But, when we consider the mode of formation (§ 25) of the crystals, from the mother liquor, we must regard it as still always a solvent ready to dissolve, and to redeposit, portions of the crystalline matter, when slight variations of temperature or pressure tend to cause such actions. Now as the specific gravity of the liquor is less, by something like 15 per cent., than the specific gravity of the solid crystals, it must *tend* to find its way upwards, and will actually do so, however slowly, until stopped by the already solidified impermeable crust, or until itself becomes solid on account of loss of heat by conduction outwards. If the upper crust were everywhere continuous and perfectly rigid the mother liquor must, inevitably, if sufficient time be given, find its way to the highest places of the lower boundary of the crust, and there form gigantic pockets of liquid lava tending to

break the crust above it and burst up through it.

§ 37. But in reality the upper crust cannot have been infinitely strong; and, judging alone from what we know of properties of matter, we should expect gigantic cracks to occur from time to time in the upper crust tending to shrink as it cools and prevented from lateral shrinkage by the non-shrinking uncooled solid below it. When any such crack extends downwards as far as a pocket of mother liquor underlying the wholly solidified crust, we should have an outburst of trap rock or of volcanic lava just such as have been discovered by geologists in great abundance in many parts of the world. We might even have comparatively small portions of high plateaus of the primitive solid earth raised still higher by outbursts of the mother liquor squeezed out from below them in virtue of the pressure of large surrounding portions of the superincumbent crust. In any such action, due to purely gravitational energy, the center of gravity of all the material concerned must sink, although portions of the matter may be raised to greater heights; but we must leave these large questions of geological dynamics, having been only brought to think of them at all just now by our consideration of the earth antecedent to life upon it.

§ 38. The temperature to which the earth's surface cooled within a few years after the solidification reached it must have been, as it is now, such that the temperature at which heat radiated into space during the night exceeds that received from the sun during the day by the small difference due to heat conducted outwards from within.* One year after the freezing of the granitic

* Suppose, for example, the cooling and thickening of the upper crust has preceded so far that at the surface, and, therefore, approximately for a few decimetres below the surface, the rate of augmentation of temperature downwards is one degree per centimeter. Taking as a rough average .005 c. g. s. as the thermal conductivity of the surface rock, we should have for

interstitial mother liquor at the earth's surface in any locality the average temperature at the surface might be warmer, by 6 or 80° Cent., than if the whole interior had the same average temperature as the surface. To fix our ideas, let us suppose the end of one year the surface to be 1° warmer than it would be with no underground heat; then at the end of 100 years it would be 8° warmer, and at the end of 10,000 years it would be .8 of a degree warmer, and at the end of 25 million years it would be .016 of a degree warmer, than if there were no underground heat.

§ 39. When the surface of the earth was still white-hot liquid all round, at a temperature fallen to about 1200° Cent., there must have been hot gases and vapor of water above it in all parts, and possibly vapors of some of the more volatile of the present known terrestrial solids and liquids such as zinc, mercury, sulphur, phosphorus. The very rapid cooling which followed instantly on the solidification at the surface

the heat conducted outwards .005 of a gramme water thermal unit Centigrade per sq. cm. per sec. (Kelvin Math. and Phys. Papers, Vol. III., p. 226). Hence if (ibid. p. 223) we take $\frac{1}{1000}$ as the radiational emissivity of rock and atmosphere of gases and water vapor above it radiating heat into the surrounding vacuum space (æther), we find $8000 \times .005$ or 40 degrees Cent. as the excess of the mean surface temperature above what it would be if no heat were conducted from within outwards. The present augmentation of temperature downwards may be taken as 1 degree Cent. per 27 meters as a rough average derived from observations in all parts of the earth where underground temperature has been observed. (See British Association Reports from 1868 to 1895. The valuable work of this Committee has been carried on for these twenty-seven years, with great skill, perseverance and success, by Professor Everett, and he promises a continuation of his reports from time to time.) This, with the same data for conductivity and radiational emissivity as in the preceding calculation makes $40^\circ/2700$ or 0.0148° Cent. per centimeter as the amount by which the average temperature of the earth's surface is at present kept up by underground heat.

must have caused a rapid downpour of all the vapors other than water, if any there were; and, a little later, rain of water out of the air, as the temperature of the surface cooled from red heat to such moderate temperatures as 40° and 20° and 10° Cent. above the average due to sun heat and radiation into the ether around the earth. What that primitive atmosphere was, and how much rain of water fell on the earth in the course of the first century after consolidation, we cannot tell for certain; but Natural History and Natural Philosophy give us some foundation for endeavors to discover much towards answering the great questions: Whence came our present atmosphere of nitrogen, oxygen and carbonic acid? Whence came our present oceans and lakes of salt and fresh water? How near an approximation to present conditions was realized in the first hundred centuries after consolidation of the surface.

§ 40. We may consider it as quite certain that nitrogen gas, carbonic acid gas and steam, escaped abundantly in bubbles from the mother liquor of granite, before the primitive consolidation of the surface, and from the mother liquor squeezed up from below in subsequent eruptions of basaltic rock, cause all, or nearly all, specimens of granite and basaltic rock which have been tested by chemists in respect to this question,* have been found to contain, condensed in minute cavities within them, large quantities of nitrogen, carbonic acid and water. It seems that in no specimen of granite or basalt tested has chemically free oxygen been discovered, while in many, chemically free hydrogen has been found, and either native iron or magnetic oxide of iron in those which do contain hydrogen. From this it might seem probable that there was no free oxy-

gen in the primitive atmosphere, and that if there was free hydrogen it was due to the decomposition of steam by iron or magnetic oxide of iron. Going back to still earlier conditions we might judge that, probably, among the dissolved gases of the hot nebula which became the earth, the oxygen all fell into combination with hydrogen and other metallic vapors in the cooling of the nebula, and that, although it is known to be the most abundant material of all the chemical elements constituting the earth, none of it was left out of combination with other elements to give free oxygen in our primitive atmosphere.

§ 41. It is, however, possible, although it might seem not probable, that there was free oxygen in the primitive atmosphere. With or without free oxygen, however, *but with sunlight*, we may regard the earth as fitted for vegetable life as now known in some species, wherever water moistened the newly solidified rocky crust cooled down below the temperature of 80° or 70° of our present Centigrade thermometric scale a year or two after solidification of the primitive lava had come up to the surface. The thick, tough, velvety coating of living vegetable matter, covering the rocky slopes under hot water flowing direct out of the earth at Banff (Canada),* lives without help from any ingredients of the atmosphere above it, and takes from the water and from carbonic acid or carbonates, dissolved in it, the hydrogen and carbon needed for its own growth by the dynamical power of sunlight; thus leaving free oxygen in the water to pass ultimately into the air. Similar vegetation is found abundantly on the terraces of the Mammoth hot springs and on the beds of the hot-water streams flowing from the Geysers in the Yellowstone National Park of the United States. This vegetation, consisting of *confervæ*, all grows

* See, for example, Tilden, Proc. R. S. February 4, 1897: 'On the Gases Enclosed in Crystalline Rocks and Minerals.'

* Rocky Mountains Park of Canada, on the Canadian Pacific Railway.

under flowing water at various temperatures, some said to be as high as 74° Cent. We cannot doubt but that some such *confervæ*, if sown or planted in a rivulet or pool of warm water in the early years of the first century of the solid earth's history, and, if favored with sunlight, would have lived, and grown, and multiplied, and would have made a beginning of oxygen in the air, if there had been none of it before their contributions. Before the end of the century, if sun-heat, and sunlight, and rainfall were suitable, the whole earth not under water must have been fitted for all kinds of land plants which do not require much or any oxygen in the air, and which can find, or make, place and soil for their roots on the rocks on which they grow; and the lakes or oceans formed by that time must have been quite fitted for the life of many or all of the species of water plants living on the earth at the present time. The moderate warming, both of land and water, by underground heat, towards the end of century, would probably be favorable rather than adverse to vegetation, and there can be no doubt but that if abundance of seeds of all species of the present day had been scattered over the earth at that time an important proportion of them would have lived and multiplied by natural selection of the places where they could best thrive.

§42. But if there was no free oxygen in the primitive atmosphere or primitive water several thousands, possibly hundreds of thousands, of years must pass before oxygen enough for supporting animal life, as we now know it, was produced. Even if the average activity of vegetable growth on land and in water over the whole earth was, in those early times, as great in respect to evolution of oxygen as that of a Hessian forest, as estimated by Liebig* 50

* Liebig, 'Chemistry in its application to Agriculture and Physiology.' English, 2d ed., edited by Playfair, 1842.

years ago, or of a cultivated English h field of the present day, a very improbable supposition, and if there were no decay (*eremacausis*, or gradual recombination w oxygen) of the plants or of portions, su as leaves falling from plants, the rate evolution of oxygen, reckoned as th times the weight of the wood or the d hay produced, would be only about 6 to per English acre per annum or 1½ tons p square meter per thousand years. At tl rate it would take only 1533 years, an therefore, in reality a much longer tim would almost certainly be required, to pr duce the 2.3 tons of oxygen which we ha at present resting on every square meter the earth's surface, land and sea.* B probably quite a moderate number of hu dred thousand years may have sufficed. is interesting, at all events, to remark tha at any time, the total amount of combu tible material on the earth, in the form living plants or their remains left dea must have been just so much that to bur it all would take either the whole oxyge of the atmosphere or the excess of oxyge in the atmosphere at the time above tha if any, which there was in the beginning. This we can safely say, because we almoe certainly neglect nothing considerable in comparison with what we assert when w say that the free oxygen of the earth's at mosphere is augmented only by vegetation liberating it from carbonic acid and water in virtue of the power of sunlight, and is diminished only by virtual burning† of the

* In our present atmosphere, in average condition of barometer and thermometer, we have, resting on each square meter of the earth's surface, ten tons total weight, of which 7.7 is nitrogen and 2.3 is oxygen.

† This 'virtual burning' includes *eremacausis* of decay of vegetable matter, if there is any *eremacausis* of decay without the intervention of microbes or other animals. It also includes the combination of a portion of the food with inhaled oxygen in the regular animal economy of provision for heat and power.

vegetable matter thus produced. But it seems improbable that the average of the whole earth—dry land and sea bottom—contains at present coal, or wood, or oil, or fuel of any kind, originating in vegetation, to so great an amount as .767 of a ton per square meter of surface; which is the amount, at the rate of one ton of fuel to three tons of oxygen, that would be required to produce the 2.3 tons of oxygen per square meter of surface which our present atmosphere contains. Hence it seems probable that the earth's primitive atmosphere must have contained free oxygen.

§ 43. Whatever may have been the true history of our atmosphere it seems certain that if sunlight was ready the earth was ready, both for vegetable and animal life, if not within a century, at all events within a few hundred centuries, after the rocky consolidation of its surface. But was the sun ready? The well-founded dynamical theory of the sun's heat carefully worked out and discussed by Helmholtz, Newcomb and myself,* says NO if the consolidation of the earth took place as long as 50 million years; the solid earth must in that case have waited 20 or 50 million years for the sun to be anything nearly as warm as he is at present. If the consolidation of the earth was finished 20 or 25 million years ago the sun was probably ready, though probably not then quite so warm as at present, yet warm enough to support some kind of vegetable and animal life on the earth.

§ 44. My task has been rigorously confined to what, humanly speaking, we may call the fortuitous concourse of atoms, in the preparation of the earth as an abode fitted for life, except in so far as I have referred to vegetation, as possibly having been concerned in the preparation of an

atmosphere suitable for animal life as we now have it. Mathematics and dynamics fail us when we contemplate the earth, fitted for life but lifeless, and try to imagine the commencement of life upon it. This certainly did not take place by any action of chemistry, or electricity, or crystalline grouping of molecules under the influence of force, or by any possible kind of fortuitous concourse of atoms. We must pause, face to face with the mystery and miracle of the creation of living creatures.

ADDENDUM.—MAY, 1898.

Since this lecture was delivered I have received from Professor Roberts-Austen the following results of experiments on the melting-points of rocks which he has kindly made at my request:

	Melting-point.	Error.
Felspar.....	1520° C.	±30°
Hornblende.....	about 1400°	
Mica.....	1440°	±30°
Quartz.....	1775°	±15°
Basalt.....	about 880°	

These results are in conformity with what I have said in §§ 26–28 on the probable origin of granite and basalt, as they show that basalt melts at a much lower temperature than felspar, hornblende, mica or quartz, the crystalline ingredients of granite. In the electrolytic process for producing aluminium, now practiced by the British Aluminium Company at their Foyers works, alumina, of which the melting-point is certainly above 1700° C. or 1800° C., is dissolved in a bath of melted cryolite at a temperature of about 800° C. So we may imagine melted basalt to be a solvent for felspar, hornblende, mica and quartz at temperatures much below their own separate melting-points; and we can understand how the basaltic rocks of the earth may have resulted from the solidification of the mother liquor from which the crystalline ingredients of granite have been deposited.

KELVIN.

* See 'Popular Lectures and Addresses,' Vol. I., pp. 376–429, particularly page 397.

MENTAL FATIGUE.

THE purpose of this article is to give a preliminary report of some experiments on mental fatigue made by the writer. It is expected that they will later be presented in detail, and accordingly only the method and theoretical conclusions will be now stated.

Mental fatigue may mean either the fact of incompetency to do certain mental work or a feeling of incompetency which parallels the fact or the feeling or feelings denoted by our common expressions 'mentally tired,' 'mentally exhausted.' Among the conclusions to which the experiments have led are the following: first, that the fact of incompetency is not what it has been supposed to be; second, that there is no pure feeling of incompetency which parallels it and is its sign, that consequently the mental states ordinarily designated by the phrases mentioned are not states made up of such a feeling of incompetency, but are very complex affairs; and third, that these mental states are in no sense parallels or measures of the decrease in ability to do mental work.

We have been accustomed to think of mental work in terms of mechanics. The mind has been supposed to lose its power to work as a rubber ball loses its power to bound. As the ball rebounds to a lesser and lesser height so the mind has been supposed to think with less and less vigor. We have talked as if sleep charged the mind with mental energy as a current might charge a storage-battery with electricity and that then the mind had this stock to spend. As it spent it, it could exert less and less energy in its thinking. One could easily show the impropriety of such views by demonstrating the inconceivability that the complexity of mental action should fit so simple a scheme, but it is also useful to show the same thing by proof that in the case of certain people the mind does not lose

its power to do work from having done large amounts of it. My experiments show in certain individuals no decrease in amount, speed or accuracy of work in the evenings of days of hard mental work over mornings or in periods immediately following prolonged mental work over periods preceding it.

So far as these and many other experiments go they all agree in denying that the cause for a decreased amount of mental work is such a simple lessening of some one factor, mental energy or whatever one care to call it. They would affirm, on the contrary, that we did less work when tired not because this stock of mental energy was running low, but because ideas of stopping of 'taking it easy,' of working intermittently came in and were not inhibited; because feelings of boredom led to their consequences of leaning back in one's chair, looking at the clock, etc.; because a certain feeling of physical strain weakened one's impulse to read, write or translate; because sleepiness clouded our mental vision; because headaches or eye-aches tended naturally to inhibit the processes which caused them, etc., etc.

As to the pure feeling of incompetency I fail utterly to find it in myself or to get any intelligible account of it from others. After one separates out from the feelings of mental fatigue the factors just mentioned, especially the feelings of physical pain and strain, the feelings of mental nausea at certain ideas, and the feeling of sleepiness, I do not think that he will find anything left that is worth naming.

That the feelings of fatigue which we do have are not proportionate concomitants with the decreasing ability to do mental work is shown by the fact that all the persons in our experiments reported a large measure of such feelings in cases where their mental work was quite up to the average. In general a comparison of the introspective

records of feelings with the actual mental ability displayed shows that the former are not a parallel or measure of the latter.

The quantitative results obtained would seem to show that the degree of real inability caused by mental work was very much less than has been supposed; that in ordinary life nature warns us by the complex feelings mentioned not to work mentally some time before we are really incapacitated for work. They would also suggest that the results which those investigators who have sought to measure mental fatigue in school children have obtained were due to the use of methods which did not measure the *inability*, but the *distaste* for mental work, of the children. One is tempted to put forth the paradox that real mental incompetency is the rarest of all reasons for stopping or decreasing mental effort.

The methods used to estimate the ability to do mental work are to some extent new and so worth mention. The chief was the mental multiplication of three figures by three (*e. g.*, 794×683); of two figures by three, and in some cases four by four. This work, at least for the subjects of these experiments, required the utmost concentration. It is very fatiguing (in the ordinary sense of the word). Any interruption or distracting influence is felt at once and makes successful work impossible. So one would suppose that it ought to show the influence of decreasing power to do mental work as clearly as could anything. The amount of work and the mistakes can be easily and accurately recorded.

Another method involved the addition of columns of twenty numbers, each of five figures. This does not require close concentration, but the work done should show perfectly the fact of mental fatigue in so far as that involves the accuracy and speed of associations between ideas. The speed and accuracy of discrimination of the lengths of lines and of the perception of letters were

also used. The tests were arranged so as to eliminate the effects of practice.

EDWARD THORNDIKE.

WESTERN RESERVE UNIVERSITY.

SCIENTIFIC BOOKS.

The Development of English Thought: A Study in the Economic Interpretation of History. By SIMON N. PATTEN, PH.D., Professor of Political Economy, Wharton School of Finance and Economy, University of Pennsylvania. New York, The Macmillan Co. 1899. Pp. xxvii + 415.

"We don't know him; let's heave half a brick at him." The process is simple, obvious and, to the heavens, effective. There are only too many grounds for the fear that Professor Patten's new work will be treated as a vile body for this old experiment. Everyone knows how easy it is to discredit generalization by advancing negative instances; how sweet to cavil at principles by alleging that facts have been twisted to fit; how seductive to emphasize the specialist's standpoint and to magnify its abounding limitations. I do not exaggerate in saying that it is long since I have encountered a book which lies so open, so invitingly open, to these insidious attacks; or, on the contrary, one which proves so conclusively the unfairness, superficiality, even stupidity, of such criticism. For Professor Patten sets theory in the forefront of his discussion, and the body of his work sees the persistent application of this theory. Nevertheless, he who runs may read that, in the author's mind, the theory came last, being the inference from his detailed investigations, the final form in which the multitudinous facts shaped themselves—ceased to be mere isolated phenomena and became rationally one.

Professor Patten's theory reposes on a quasi-psychological basis. Sensory ideas, or ideas brought by the senses from the environment, constitute the material of knowledge; and "sensory knowledge is merely the amplification and classification of the differences perceived by the senses." (2) Such processes produce series of mental images; these, in turn, occasion relative motor reactions. Consequently a "man's

activities are determined by that part of his ideas for which motor reactions have been provided." (3) These complicated results are, of course, affected profoundly by differences of environment. In 'local' environments motor reactions predominate, in 'general' environments sensory ideas. Thus, 'stratification of society' does not take place in obedience to such 'superficial' causes as wealth and social position, but must be referred to 'psychic' characteristics. "A race ideal differs from its elements or from an abstract concept by having a motor reaction united with it (173). * * * Before the time of Locke there were three types of Englishmen—the Puritan, the clinger and the sensualist. Locke's analysis had split the Puritan party into two parts. One section was transformed into stalwarts, who placed race ideals above reason and sense impressions, and the other into mugwumps, who made the opposite choice" (185). Viewed in this light, English society has consisted of four great classes—'Clingers, Sensualists, Stalwarts, Mugwumps' (23-32). 'Clingers' spring from 'local' environments; 'Sensualists' appear when environments become richer in objects; they break down local traditions and stand forth as conquerors. When society becomes sufficiently differentiated, 'Stalwarts' are evolved—men who love creeds and react from sensualism to asceticism. Finally, increased wealth produces 'Mugwumps,' who evince a highly developed sensory side, and so are strong in thought, but weak in action. "Its members are cosmopolitan in their sympathies; advocates of compromise and policy in politics; sceptical in thought, and agnostic in belief. They dislike ideals, creeds and utopias, and are ever ready to expose shams and cant in which other people disguise their sentiments" (31). The history of English thought is the history of the appearance, interaction and transformation of those classes. "The sensualist is the original unmodified Englishman, who retains the dross of primitive times. The clinger is the result of qualities grafted on English nature by the supremacy of the Church. The stalwart is the concrete Puritan. The conflict was a three-cornered fight in which either the sensualist or the Puritan was the aggressor, while the clin-

ger joined in with the defensive party (1 * * * The three-cornered fight had to go until some solution could be found other than those these parties could offer. A new type of man was demanded, a type endowed with mental qualities different from those Englishmen then possessed" (141-2). If the matter were treated in this way one is freed from former methods of interpretation and gets to know English character as it actually was and is its own peculiar nature (cf. 48). It ought to be said that our author himself recognizes limitations of this standpoint and not merely his title-page. "Economic conditions create the primary motor reactions, put them to various uses and give them a form quite different from that they have at the outset. * * * The consequence is that a motor reaction, after losing its primal economic importance, responds to an abstract instead of concrete phenomena" (1). Further, it ought to be added that the most interesting, and, as I believe, the most effective part of the work is the second half where this limitation does not press so heavily. The execution of this portion, which deals with English thought as ruled by the 'Mugwump' is a most important contribution to the subject one that all English philosophers, especially those who see no good thing outside of Germany, would do very well to mark, learn and inwardly digest. "If we view English thought from this standpoint there are three clearly defined epochs. In the first Hobbes states the problem without solving it; Locke is the economist on the upward curve; Newton is the thinker on the downward curve. In the second Mandeville states the problem; Hume changed from an economist into a philosopher and Adam Smith from a philosopher into an economist. The third epoch, beginning with Malthus, ends when Mill is transformed into a philosopher and Darwin into a biologist" (55).

Taking the book as a whole, no one can fail to be impressed with its freshness, originality and great brilliance in some places. While the style is plain and straightforward for the most part, incisive sayings—almost epigrammatic on occasions—attract attention or serve to stimulate rapid thought. Indeed, sometimes Professor Patten contrives to cast a flood of light

over an entire period by their use. I had marked a large number of penetrating purviews and new reflections for quotation, but limits of space forbid more than briefest reference to a very few. The theory of curves of thought (48); the value of monastic influences (71); the contrasts between communal and family life (81, 192, etc.); the relation of Catholicism and Protestantism to vice and crime (94); the misfortunes of the Reformation (104); the suddenness of English civilization (126); Locke's office (162); the meaning of Deism (175); the contrast between England and France (187, 281); the presentations of Wesley and Whitefield (250); the 'origins' of Adam Smith (264); the criticism of current sociology (333); Romanticism and religion (353)—all serve to illustrate the originality and one might almost say weird suggestiveness of Professor Patten's inferences, and other instances might be adduced indefinitely.

On the other hand, a few things give one pause. To begin with, Professor Patten will perhaps not take it amiss if a Scot informs him that Scottish thought is not a variant of English. Hume and Adam Smith and the Mills would not have been what they were had their nationality lain south of the Tweed. At the same time, I am well aware how difficult it is for the foreigner to understand that the Cheviots divide, if not two civilizations, then two ways of thinking. The doctrine of the 'manly man,' the 'womanly man,' and so forth (255, 318, 341, etc.), seems a little far-fetched to be made so much of; perhaps it applies in the case of John Stuart Mill. The bath theory (192) of English civilization; the treatment of Calvinism (110, etc.); the contrast between Cavalier and Puritan (119); the gulf between the upper and lower classes in England (130); the emphasis upon clothing (191); the passage from a liquor to a sugar diet (381)—all seem to me to be somewhat fanciful or, at least, to be used in support of conclusions which do not necessarily connect with them. Many of the 'Concluding Remarks' are vitiated by the author's foreign standpoint. For example, the identification of religion and economics, while strikingly true of the United States, is incomparably less true of England, and must remain so till the Anglican Church loses its endowments. I ought to add

that some of these objections would probably appear less forcible to one fully informed on economic questions.

Finally, the appreciations of English philosophical thought are wholly admirable. The value of the new lights cast on Locke (158), Mandeville, Hume (215, 223), the Mills, especially the son (331), Darwin (345), and the present position of English philosophy (377) and religion (398), cannot be overestimated at the contemporary juncture. Emphasis ought to be laid on the masterly discussions of Ricardo and Adam Smith; the interpretation of the former is most illuminating.

So far as I am capable of judging, the book is obviously the work of a very able man and one unusually well informed; of a man who has extraordinary capacity for seeing and telling truths pointedly, even though he may miss the whole truth time and again. In any case, it must be reckoned with and cannot miss the exercise of wide influence, whether this be of a negative or positive character.

R. M. WENLEY.

UNIVERSITY OF MICHIGAN.

Peruvian Meteorology, 1888-1890. Compiled and prepared for publication by SOLON I. BAILEY, under the direction of EDWARD C. PICKERING. *Annals of the Astronomical Observatory of Harvard College*, Vol. XXXIX., Part I. 4to. Cambridge, Published by the Observatory. 1899. Pp. 153. Pls. VI.

It is safe to say that no publication has been awaited with greater interest among meteorologists than the volume now before us. Ever since the establishment of the permanent Southern Station of the Harvard College Observatory at Arequipa, in 1891, and of the auxiliary meteorological stations in connection with it, every meteorologist the world over has been anxious to have access to the data which have been gathered concerning the climatic conditions of that unique region. The notable discoveries made on the photographic plates from Arequipa have turned the attention of every astronomer towards Peru. Now the meteorological world likewise turns towards Peru in the study of the records which are for the first time accessible. Readers of SCIENCE will remember that the

astronomical and meteorological work of the Observatory of Harvard College in Peru is the result of a bequest left to the Observatory in the will of Mr. Uriah A. Boyden, in 1887. Under the terms of the will this money was to aid in the establishment of an observatory "at such an elevation as to be free, so far as practicable, from the impediments to accurate observation which occur in observatories now existing, owing to atmospheric influences." It was in connection with the study of the atmospheric conditions of the desert strip of the west coast of South America, with a view to determining the best possible site for the new observatory, that the early meteorological observations in Peru were undertaken. The stations selected for the taking of these preliminary observations were Mollendo, Arequipa, Vincocaya, Puno and Chosica. The first four stations are between latitude S. $15^{\circ} 40'$ and S. $17^{\circ} 5'$, on the *Ferrocarril del Sur del Peru*, which runs from Mollendo, on the sea coast, northeast to Puno, on Lake Titicaca, a distance of 325 miles (by rail). Mollendo is immediately on the coast (altitude 80 feet). Arequipa is at a distance of 80 miles in a direct line from the Pacific Ocean, at an altitude of 7,550 feet. Vincocaya is 14,360 feet above sea level, on a desolate plateau, near the crest of the Western Cordillera. Puno (12,540 feet) is on the western shore of Lake Titicaca. The station at Chosica was situated about 25 miles northeast of Lima (altitude 6,600 feet). A few observations, chiefly of cloudiness, were made at the Pampa Central, near the central western part of the Desert of Atacama, in Chile.

These early observations were made during the years 1888-1890, with more or less completeness. They are, however, preliminary. They were almost all made by observers who had had little or no experience and who received no compensation for their services. The instrumental equipment in use at the different stations varied considerably; the hours of observation were not always the same; the location of the instruments was sometimes changed. In short, the work as a whole was done in an unsystematic and incomplete and often in a very inaccurate way. This was, of course, absolutely unavoidable. It was impossible to secure

trained observers, to inspect the stations, to test the instruments. The observations were therefore, liable to be considerably in error. Thus, in connection with the minimum thermometer readings at Chosica the statement made in a note that it is probable that the lower end of the index in the minimum thermometer was read, instead of the upper end. And in the wind observations at Arequipa and Vincocaya it is noted that "the direction of wind was always given, even if the remark appended was 'calm' or 'dead calm.' Apparently the position of the wind-vane was not recorded, whether at the time wind was observed or not." These two cases will serve to indicate the sort of errors which inevitably appear in these records. We do not intend to criticize adversely the publication of these early Peruvian observations, but merely to point out the necessary inaccuracies. Professor Pickering says very clearly in the preface: "These observations must not be regarded as indicating the accuracy of those made later. * * * It must be remembered that it was not possible under the conditions then existing to obtain observations of the accuracy of those made by professional observers at permanent and easily accessible observatories." And again, on page 68, Professor Bailey says: "The results are perhaps as reliable as are possible in such outlying stations, where experienced observers cannot be obtained; frequent supervision is impossible."

The published observations comprise twenty-nine tables. The data are by no means equally complete for all stations. At Mollendo, Arequipa and Vincocaya the instruments in use were the maximum, minimum and ordinary thermometers, thermograph and rain-gauge. At Arequipa a solar radiation and a wet-bulb thermometer were also used. At Puno the observations were continued but a short time and there was no thermograph. At the Chosica station, in addition to the above-named instruments, there were a barograph, sunshine recorder and pole-star recorder. At Pampa Central cloud observations only were made, four times daily. There are several tables showing the hourly means of the barograph and thermograph, and a comparison of thermometer and thermograph hourly and monthly means. Curves are also

given showing the diurnal variation of temperature at Mollendo, Arequipa, Vincocaya and the Chosica station; the diurnal variation of pressure for the Chosica station, and the annual range of the afternoon oscillation of pressure at the Chosica station. Beyond some general remarks in explanation of the tables, there is no discussion of the observations.

Besides the meteorological portion proper, this volume contains a very attractive account, by Professor Bailey, with some excellent illustrations, of the volcano El Misti (19,200 feet), and of the establishment of the now famous Misti meteorological station on its summit. There is also a carefully compiled account of *The Configuration and Heights of the Andes*, which will be of distinct value to geographers.

We presume that Professor Pickering may receive some rather severe criticism in certain quarters for the publication of meteorological data which are so incomplete and which, doubtless, have very many inaccuracies. But we agree with him in believing that, considering the interest of the region in which these observations were made, and the lack of information concerning its meteorology, such results deserve publication, provided careful statement is made in regard to the circumstances under which the data were collected. Professor Pickering and Professor Bailey have both made these conditions perfectly clear, and we believe that the results, when viewed in the light of these statements, will prove not only of great interest, but also of great value.

R. DEC. WARD.

The Elements of Physical Chemistry. By J. LIVINGSTON R. MORGAN, PH.D., of the Department of Physical Chemistry, Columbia University. First edition, first thousand. New York, John Wiley & Sons; London, Chapman & Hall, Limited. 1899. Pp. 299.

This little book deals with the gaseous state, the liquid state, the solid state, solution, the rôle of the ions in analytical chemistry, thermochemistry, chemical change, including equilibrium and chemical kinetics, phases and electrochemistry.

The aim of the author is to present the elements of physical chemistry in brief form to

those who do not have the time or opportunity to go more extensively into the subject. An examination of the work will bring out much that is of interest and importance, and a careful study of it will help a beginner to obtain an insight into the subject. But the objection might be raised to the work as a whole that it seems to deal rather with conclusions and generalizations than with the evidence upon which such are based. Further, there are many omissions which it is difficult to account for. Thus, under liquids no mention is made of Kopp's work on atomic volumes; of the work of Pulfrich, Landolt, Gladstone, Brühl and others, on the refractivity of liquids; of the rotation of the plane of polarized light and the Le Bel-Van't Hoff hypothesis; of the work of Perkins, and of Rodger and Watson on magnetic rotation; of Thorpe and Rodger on viscosity; of Ramsay and Shields on the surface-tension of liquids as applied to the determination of molecular weights. It would seem that such important work as the above ought to be referred to briefly even in an elementary treatise designed to cover the whole field of physical chemistry. An examination of the book will show, further that much of the more recent experimental work has not been taken into account, indicating that text-books which have been published several years, rather than the original literature, have been drawn upon as the source of material. As in most text-books, so here, an occasional statement is not quite accurate. But what book is perfectly logical, thoroughly comprehensive and rigidly exact throughout?

HARRY C. JONES.

BOOKS RECEIVED.

The Anatomy of the Central Nervous System of Man and of Vertebrates in General. LUDWIG EDINGER. Translated from the fifth German edition by WINFIELD S. HALL, assisted by P. L. HOLLAND and E. P. CARLTON. Philadelphia, F. A. Davis Company. 1899. Pp. xi + 446.

Marriages of the Deaf in America. EDWARD ALLEN FAY. Washington, Gibson Bros. 1898. Pp. vii + 527.

A Century of Vaccination. W. SCOTT TEBB. London, Swan, Sonnenschein & Co. 1899. Second Edition. Pp. 452.

Essai critique sur l'hypothèse des atomes dans la science contemporaine. ARTHUR HANNEQUIN. Paris, Alcan. 1899. Second Edition. Pp. 457.

Social Phases of Education in the School and the Home. SAMUEL T. DUTTON. New York and London, The Macmillan Company. 1899. Pp. viii + 259.

The Fur Seals and Fur Seal Islands of the North Pacific Ocean. DAVID STARR JORDAN. Washington, Government Printing Office. 1898. Pp. 606 and 13 Plates.

SCIENTIFIC JOURNALS AND ARTICLES.

American Chemical Journal, May. The Action of Metals on Nitric Acid: By P. C. Freer and G. O. Higsley. The reduction of strong acid is due to the metals alone, but with dilute acid both metal and hydrogen take part in the reduction. On the Dissociation of Phosphorus Pentabromide in Solution in Organic Solvents: By J. H. Kastle and W. A. Beatty. On the Color of Compounds of Bromine and of Iodine: By J. H. Kastle. The explanation offered is that the color is due to a slight dissociation of the solid substance. On the Formation of Potassium B-ferricyanide through the action of Acids on the Normal Ferricyanide: By J. Locke and G. H. Edwards. A very small amount of acid is sufficient to produce this change without the presence of any oxidizing agent. Trinitrophenylmalonic Ester: By C. L. Jackson and J. I. Phinney. The Relation of Trivalent to Pentavalent Nitrogen: By A. Lachman. The authors report the results so far obtained in an attempt to establish the trivalent or pentavalent condition of nitrogen, in various compounds, by the action with zinc ethyl.

J. ELLIOTT GILPIN.

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES—SECTION OF BIOLOGY, MARCH 14, 1899.

OBSERVATIONS on the Germ Layers of Teleost Fishes: F. B. Sumner.

Mr. Sumner showed that Teleost eggs can be divided into two types according to their approach to the holoblastic form of cleavage; that germ disc and yolk cannot strictly be contrasted as epiblast and hypoblast respectively; that the germ-ring arises either by involution or delamination or both; that the 'prostoma' of

Kupffer is a reality. Kupffer's contention the prostoma represents the entire blastopore however, wrong. Mr. Sumner showed also the hypoblast in the stone-catfish is derived partly from the posterior lip of the prostoma and partly from the germ-ring; perhaps wholly from the prostoma in the trout; that function of Kupffer's vesicle, which arises cleft between the prostomal entoderm and involuted margin of the blastoderm, is probably the absorption of fluid nutriment elaborated from the yolk by the periblast.

Further Notes on the Echinoderms of Bermuda: H. L. Clark. Presented by Professor C. L. Bristol.

Dr. Clark's paper sums up the work on Echinoderms collected by the New York University Expedition in the summers of '97 and '98, and presents a check list of the Echinoderms thus far reported from Bermuda. The collection of 1898 was especially rich in holothurians, containing many species hitherto collected, and several others to the list from Bermuda, and new to science. From his work on *Stichopus* Dr. Clark suggests that the different forms found in Bermuda may be mature and immature individuals of *S. möbi* (Semp.). *Synalaxis vivipara* was found under conditions widely different from those in Jamaica. The new *Synalaxis* is allied to *S. inhaerens*, and Dr. Clark named it *S. acanthina*.

The Echinoderms from Bermuda are distributed as follows: Asteroidea, 4; Ophiuroidea, 7; Echinoidea, 8; Holothuroidea, 10.

The Sequence of Moults and Plumages of the Passerine Birds of New York State: Jonathan Dwight, M. D.

Dr. Dwight fully described the process of moulting and its relation to the plumage about one hundred and fifty species of land birds common to eastern North America. The ear plumage of these birds was described, together with the time and method of the acquisition of later plumages. Stress was laid upon the underlying principles of the sequence or succession of plumages peculiar to each species, and the moults and plumages were classified according to a definite scheme by the author.

GARY N. CALKINS,
Secretary.

SECTION OF GEOLOGY AND MINERALOGY, APRIL 17, 1899.

PROFESSOR J. J. STEVENSON in the Chair.

Dr. A. A. Julien presented a 'Note on a Feldspar from the Calumet Copper Mine, Keweenaw Point, Michigan,' with specimens collected by him at the first opening of that mine. The wide distribution of the mineral was pointed out, through both the Portage Lake and Ontonagon districts, as drusy linings of cavities in the amygdaloid and in crystals scattered through the cement of the copper conglomerate. The crystals were of simple type, a rhombic prism with orthodome modification on obtuse angles, but both faces and cleavage-planes were often distinctly curved. By the complete analysis presented, it was identified as a normal orthoclase, with an unusually large proportion of protoxides in isomorphous replacement. These seemed to bear a relationship to the instability of the mineral, indicated by its general partial decomposition; to its remarkably low Specific Gravity, 2.455; and possibly, in part, to the curvature of its planes.

Professor J. F. Kemp called attention to the unusual presence of cobalt oxide in a feldspar, shown in the analysis.

Dr. E. O. Hovey then gave a very interesting description, with lantern illustrations, of 'Geological and Mineralogical Notes Gathered during a Collecting Trip in Russia,' in connection with the excursions of the recent International Congress. Many of the lantern pictures were beautifully colored; they referred in part to ethnographic observations; and the accompanying remarks awakened much interest.

ALEXIS A. JULIEN,
Secretary of Section.

GEOLOGICAL CONFERENCE AND STUDENTS' CLUB OF HARVARD UNIVERSITY.

Students' Geological Club, March 28.—Mr. C. H. White explained a method of field work that has been developed by the members of the Appalachian Division of the United States Geological Survey. It can be used only in regions of distinctly bedded rocks of low dip, and has the merit of greatly facilitating both field and laboratory work. Mr. A. W. Grabau exhibited a

number of new paleontological specimens which were collected by Mr. W. W. Dodge from the middle Cambrian, at Braintree, Mass. These included nine very perfect specimens of a new species of *Acrothele*.

Geological Conference, April 4, 1899.—In 'A Comparison of Snow-chart with Ice-lobes,' Mr. R. R. Kent described a method of comparing the location of snow accumulations of the present time with those of glacial time; the position of the former being indicated by snow-charts and the latter by frontal moraines. From these snow-charts, issued weekly by the Weather Bureau, composite charts for the winters of '96-'97 and '98-'99 were constructed. These showed that the lines of equal snow-averages follow lobations which in character and position closely correspond to the glacial lobes. The driftless area of Wisconsin was thus shown to have been an area of minimum snow-average, during the past winter. In their tendency toward local retention, the distributions of snow for these two winters show in miniature a remarkable likeness to the supposed distribution of glacial times.

In considering the causes of annual isochronal lobations, maps were shown which gave lines indicating equal frequency of exposure of local areas to traversal by cyclonic areas during these winters. These present a remarkable resemblance between these lines and the distribution of snow. Accordingly, the speaker concluded that the lobations shown by the charted averages are due to meteorological rather than to topographical causes.

Dr. R. A. Daly communicated the results of a study of etch figures produced with hydro-fluoric acid and the caustic alkalis on the principal planes of the amphiboles, with especial reference to the cleavage prism. He summarizes the chief problems which he studied in this connection as follows: "(1) The orientation of the amphiboles—that of *Tschermak* (*Dana*, *Lacroix*) is preferred to that of *Norden-skiöld* (*Hintze*); (2) the orientation of cleavage pieces of amphiboles; (3) the limits of variation on (110), (010) and (100) of the different species of amphibole—these can be used for determinative purposes; (4) the testing of *Retgers'* law that isomorphous bodies must have, using the

same reagent, similar etch figures on the same face—it is concluded that, if the law hold actinolite and all amphiboles without a sesquioxide, cannot be isomorphous, with a hornblende; (5) the holohedral character of all amphiboles—it is established for monoclinic and orthorhombic species; (6) the demonstration of the orthorhombic character of anthophyllite and of gedrite, a doubt of which has been expressed by Hintze and others; (7) a comparison between the amphiboles and pyroxenes as to etching properties—an extraordinary likeness in the figures produced on the pinacoids and on the artificial face of actinolite representing in position the plane (110) of diopside seems to ally the two groups even more closely than has been suspected; (8) the proof that close attention must be given to the *method* of etching with hydrofluoric acid."

The discovery of anomalous etch-pits on a hornblende from Philipstad, Sweden, led to the recognition of a new variety of hornblende characterized by a well-marked zonal structure, an unusually small optical angle, an unusual pleochroism and absorption scheme, and a peculiar chemical composition. For details see Proceedings of the American Academy of Arts and Sciences, Vol. XXXIV., Nos. 15 and 16, March, 1899.

J. M. BOUTWELL,
Recording Secretary.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

At the meeting of the Academy of Science of St. Louis of May 1, 1899, nineteen persons present, the Secretary presented by title a paper by Professor F. E. Nipher, on gravitation in gaseous nebulae.

Dr. Amand Ravold exhibited cultures and microscopic specimens showing the *Micrococcus intercellularis meningitidis* of Weichselbaum, obtained from a case of cerebro-spinal meningitis, and stated that this case afforded an interesting instance of germ infection through the placenta, inasmuch as the cerebro-spinal system of an unborn child of the patient was likewise found to be infected by the germ, from which source, in fact, the specimens exhibited were derived.

Mr. H. von Schrenk presented the general re-

sults of a study of certain diseases of the yepine, illustrating his remarks by the exhibit of a number of specimens showing the characteristic phenomena of the diseases and fruiting bodies of the fungi which cause them.

WILLIAM TRELEASE,
General Secretary.

UNIVERSITY OF COLORADO SCIENTIFIC SOCIETY.

The following papers have been presented during the year: 'Methods of determining Solar Parallax,' Dr. Frederick L. Chase, of University; 'A Theory of the Nature of Photography,' Dr. Francis Kennedy; 'The Velocity of Electrical Waves,' Dr. Wm. Duane; 'Graphical Methods of determining Stresses in framed Structures,' Mr. Frederick T. Rubidge; 'Wireless Telegraphy,' Dr. Wm. Duane.

The Society meets the first Friday in each month from November to March. All members of science are invited to attend the meetings.

FRANCIS RAMALEY,
Secretary.

BOULDER, COLO., April 28, 1899.

DISCUSSION AND CORRESPONDENCE.

THE STORAGE OF PAMPHLETS.

RECENT correspondence on this subject in pages of SCIENCE suggests that a description of the method adopted in my private library also in that of the Geological Department of British Museum, may interest some of your readers.

The pamphlet-box finally evolved after so many years of experiment is constructed thus: a sheet of wood (a), to each side of which is hinged (at h) a half-box (b). When closed, the half slightly overlaps the other by a rebated edge, so as to exclude dust; they may be fastened by a catch, but this is quite unnecessary; the smaller and lighter makes. When open, both sides and back lie flat on the table; or, if space be limited, one side can hang down over the edge of the table or can be kept standing up. In the lighter makes the sides are of pasteboard, and are hinged to the back by a line hinge (h), the outside is all covered with stout binder's cloth and the inside is lined with white glazed paper. In the heavier makes (suitable for large quartos or for a public library) the

sides are of thin wood, similarly hinged to the back, but on the outside the back and the hinges are covered with roan. Attached to the inner side of the tail end of the back is a loop of tape or roan, by which the box can be pulled out from the shelf. The outside measurements of the size adopted in my library for ordinary pamphlets are, height, $11\frac{1}{2}$ inches; depth, 9 inches; thickness, $3\frac{1}{2}$ inches. The thickness of the material is from $\frac{1}{4}$ to $\frac{1}{2}$ inch according to its position.

The merits of this type of case are extreme simplicity, readiness of access to pamphlets, freedom from dog-earing the corners or folding the wrappers as pamphlets are taken in and out. To refer to a pamphlet one simply places the back of the case on the table, lets fall the two sides on to the table and turns over the pamphlets until the desired one is found. Without

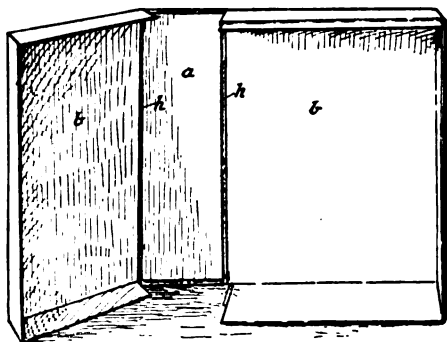


FIG. 1. The pamphlet-case open and seen from the inside.

removing the pamphlet one can turn over the pages, note the passage required and then without further ado close the sides of the pamphlet-box just as one would close a bound book, and replace it on the shelf. The cases are light, dust-proof and durable; and the lighter ones cost me 2s. 9d. (66 cents) apiece when ordered by the half gross.

As for arrangement, each worker will follow the method that suits him best. I sort the pamphlets first into subjects, and within each subject arrange them alphabetically under authors' names; those of each author are placed chronologically. Any number of boxes may go to one subject. Each is labelled on the back

with a white paper label on which the subject is stencilled in black, while the letters contained in that particular box are marked in broad soft pencil, easily changed as required (see Fig. 2).



FIG. 2. The pamphlet-case closed as it stands on the shelf.

In this way the boxes devoted to Crinoidea have grown from 1 to 14 and the position of no pamphlet has ever been in doubt.

Of course a card-catalogue is a necessary adjunct to a collection of any size, as it enables one to assign a doubtful pamphlet to any subject, and to find it again by a symbol pencilled on the catalogue slip.

It may be paternal prejudice, but I certainly consider this form of case simpler and more effective than any I have seen or read about. I do not say that it is cheaper.

F. A. BATHER.

THE MARINE BIOLOGICAL LABORATORY AT WOOD'S HOLL.

'THE ANNUAL ANNOUNCEMENT OF THE MARINE BIOLOGICAL LABORATORY.'*

THE Twelfth Session of the Marine Biological Laboratory will begin on June 1st, and will continue for four months. This session promises to be the most successful in the history of the Laboratory. While the courses of instruction heretofore offered will be maintained by an exceptionally strong staff, three entirely new courses have been added, these courses in

* Copies of the Announcement may be had on application to the Director, Professor C. O. Whitman, University of Chicago, or to the Assistant Director, Professor Ulric Dahlgren, Princeton University.

(Cytology, Physiology and Psychology) being under the immediate supervision of men eminently fitted for their work.

The course in Cytological Research will be conducted by Professor Watasé, with the assistance of Mr. W. H. Packard. The course is designed for a limited number of students who are prepared to begin investigation. A special problem will be assigned to each member of the class, and methods of dealing with it will be suggested. The laboratory work will be accompanied by a series of lectures on general cytological subjects, designed to give a view of the field of cellular biology as a whole, and at the same time to indicate the bearings of the problems under investigation.

The course in General and Comparative Physiology will be conducted by Dr. Loeb, assisted by Drs. Norman, Lyon and Mathews, and will consist of laboratory work and lectures. The following is a brief outline of the work:

I. The Tropisms of Animals. Galvanotropism, Heliotropism, Geotropism and Compensatory Motions, Chemotropism, Heterotropism in sessile and free forms.

II. Effects of External Influences upon Living Matter (lack of oxygen, acids and alkalies, temperature, etc.).

III. Physiological Morphology. Experiments on Growth and Development, Regeneration and Heteromorphosis.

IV. Comparative Physiology of the Central Nervous System and Comparative Psychology.

V. Comparative Physiology of Digestion.

VI. Comparative Physiology of Secretion.

VII. Micro-chemistry.

In Comparative Psychology, Dr. Edward Thorndike will give a course of lectures on the Sense-powers, Instincts, Habits and Intelligence of Animals, and will direct the work of a few students in this department.

Opportunities for work in Botany are especially inviting. Drs. Davis and Moore, as heads of the department, will have general charge of the laboratory.

The course of lectures in Plant Morphology and Physiology is supplied by such a strong

corps, and the subjects are of such scientific importance, that we copy the program in full.

A COURSE OF LECTURES ON PLANT MORPHOLOGY AND PHYSIOLOGY.

First Week, July 5-12.—Erwin F. Smith, 'Fungi'; D. T. MacDougal, 'Physiological Subjects'; Douglas H. Campbell, 'The Evolution of the Sporophyte in the Archegoniates and Flowering Plants.'

Second Week, July 12-19.—Miss Clara E. Cummings, 'Lichens'; L. M. Underwood, 'The Evolution of the Hepaticæ'; Rodney H. True, 'Plant and Poisons.'

Third Week, July 19-26.—H. J. Webber, 'Spermatogenesis, Development of Embryo Sac, and Fertilization in Gymnosperms'; C. O. Townsend, 'Physiology of the Plant Cell.'

Fourth Week, July 26-August 2.—J. M. Macfarlane, 'Plant Irritability'; G. F. Atkinson, 'Higher Fungi.'

Fifth Week, August 2-9.—J. M. Macfarlane, 'Physio-morphology of a Few Angiospermic Orders'; Henry Kraemer, 'The Unorganized Contents of Plant Cells of Plants.'

Sixth Week, August 9-16.—D. M. Mottier, 'Cytological Studies on the Pollen and Embryo-sac of Angiosperms'; D. P. Penhallow, 'Paleobotany.'

Within the last few years workers at Wood Holl have derived great profit from the free discussion of various biological methods, facts and theories. During the coming summer there will be three seminars: The Neurological, Biological and Botanical—a series of lectures on Zoological Technique, and the customary course of 'Evening Lectures.' The latter are designed to present the results of research in different lines and departments, in so far as these are of general interest.

There are thirty names on the list of officers of instruction, and fifty-four names on the list of lecturers. In these two lists fully thirty-five educational institutions are represented.

GEOLOGICAL EXPEDITION OF DR. BECKER TO THE PHILIPPINES.

DR. GEO. F. BECKER, the expert economic geologist, who, early last summer, was sent by the Director of the U. S. Geological Survey under a cooperative arrangement with the War Department, to Manila to make a reconnaissance of the geologic structure and mineral resources of the Philippines.

sources of the Philippines, has been prevented by the uncertainty of the political situation and the state of war there existing from prosecuting these investigations, through no fault, however, of either Admiral Dewey or General Otis, both of whom would ere this have provided the facilities for safe travel about the islands, etc., if it had been possible to do so. From recent advices from the military authorities at Manila, however, it appears that, not content to rest in idleness, Dr. Becker early attached himself to the Bureau of Military Information of the Army, and soon became the right-hand man of Major J. F. Bell, in charge. Official reports and papers that have since passed between Major Bell and the Commanding General, and letters from the officers to Director Walcott, record numerous valuable services rendered by Dr. Becker to the army through the Bureau of Military Information, and also repeated acts of gallantry and soldierly usefulness in action, and accord him high praise for his conduct. He is repeatedly and strongly complimented by his military superiors, from Major Bell to Generals MacArthur and Otis. The reports, which cover events only to the middle of March, mention no fewer than 14 military reconnaissances and active engagements had with the forces, in all of which Dr. Becker took part.

It has not yet been determined by the Director of the Survey how long Dr. Becker shall remain in the Philippine Islands, but it is believed that he will be able to make some substantial progress with his geologic investigations before he is recalled. Being skilled in rapid field observation, he will be able to advance the work rapidly if once he gets at it. It is not improbable that he is even now doing stratigraphic geology in the Island of Negros, with a view to correlating its structure with that of Cebu. At least, he expressed the hope when he last wrote to Director Walcott, March 1st, of being able to do this in April and after that of going to Cebu and studying the coal deposits.

It is reported that Dr. Becker contemplates returning to America via the Suez Canal and of making a study en route of the great tin deposits at or near Singapore.

W. F. M.

MAY 5, 1899

CONVERSAZIONE OF THE ROYAL SOCIETY.

THE first *Conversazione* of the season was held by the Royal Society at Burlington House, on May 3d. The guests were received by the President, Lord Lister, and a large number of men of science was present. The following particulars concerning the exhibits, which were of a more strictly scientific character than usual, are taken from the *London Times*: Professor Arthur Thomson exhibited a model to illustrate how natural curliness of the hair is produced. An exhibit from the Marine Biological Association of Plymouth illustrated methods of feeding of marine animals by means of living and preserved examples. A series of selected animals from the neighborhood of Plymouth was shown, illustrating different methods practiced for securing food. The Association also showed charts illustrating the distribution of the fauna and bottom deposits near the 30-fathom line from the Eddystone grounds to Start Point. Dr. Francisco Moreno, who has done so much for the exploration of Patagonia, exhibited a portion of skin of an extinct ground-sloth from a cavern in southern Patagonia, which has been exciting great interest among naturalists. To Dr. Moreno was also due a fine plaster reproduction of the skeleton of *Toxodon platensis*, an extinct ungulate quadruped from the Pampa formation, province of Buenos Ayres, Argentina. Dr. Woodward's selection of zoological specimens from Christmas Island, Indian Ocean, collected by Mr. C. W. Andrews, was of special interest, containing, as it did, some remarkable forms of insects, birds, and even rats. Not less interesting was the varied collection of birds, insects, shells, etc., brought home by Dr. H. O. Forbes and Mr. Grant from Sokotra.

Dr. Manson and Surgeon-Major Ross showed microscopes beneath which were displayed specimens of mosquitoes, showing the development of the parasites of malaria in their tissues, and also of the same parasites assuming deadly dimensions in the human tissues.

Among other exhibits were the new element Victorium, of the Yttrium group, one of the latest results of Sir William Crookes's long continued researches in phosphorescent spectra; Mr. Saville-Kent's natural-color photographs

of various zoological and botanical subjects; Mr. Carus-Wilson's specimens of decomposed flints; Wehnelt's electrolytic contact breaker, which seems capable of producing extraordinary results; Mr. Everard im Thurn's beautiful water-color sketches of Guiana orchids; Mr. Shelford Bidwell's experiments demonstrating multiple vision; Mr. Joseph Goold's intersection patterns in compound-vibration curves; Sir Norman Lockyer's photographs of stellar spectra, and a very delicate and threadlike photograph of a meteor taken by Mr. C. P. Butler on the night of April 8, 1899.

Among the new instruments which specially attracted attention was the radiation recorder of Professor H. L. Callendar, so delicate that it shows when the slightest haze passes across the sky. The microscopic specimens illustrating the further researches which have been made into the effects of strain in metals by Professor Ewing and Mr. W. Rosenhain are noteworthy. Mr. A. Mallock's ingenious adaptation of thin films of pyroxyline for use as mirrors deserves mention, as do also Mr. H. N. Dickson's series of charts illustrative of temperature and salinity in the North Atlantic. The lantern exhibitions were particularly attractive, especially Mr. Kearton's slides illustrating the haunts and habits of British birds. Dr. Sorby also used the lantern to show some beautiful slides of Actiniae and other marine animals, and Mr. W. Duddell, oscillographs, applied to alternate current wave-forms, and to the Wehnelt interrupter.

SCIENTIFIC NOTES AND NEWS.

THE next meeting of the American Society of Naturalists will be held at New Haven, Conn., during Christmas week. Most of the 'affiliated societies' have signified their intention of meeting at the same place.

At the annual meeting of the American Academy of Art and Sciences, held May 10, 1899, the Rumford medal was, on the recommendation of the Rumford Committee, awarded to Mr. Charles F. Brush, of Cleveland, for 'the Practical Development of Electrical Arc Lighting.'

PROFESSOR C. F. CHANDLER, of Columbia Uni-

versity, has received the regular nomination for President of the Society of Chemical Industry. The election takes place in July at an annual meeting. This Society numbers 3000 chemists, of whom nearly 600 reside in the United States. Its headquarters are in London; it has sections also in Liverpool, Manchester, Nottingham, Glasgow, Leeds, Manchester and New York. In the list of former Presidents appear the names of Sir Henry E. Roscoe, Sir Frederick Abell, Walter Weldon, H. Perkin, E. K. Muspratt, David Howard, Professor James Dewar, Ludwig Mond, Lowthian Bell, E. Rider Cook, J. Eme Reynolds, Sir John Evans, E. C. C. Stanfield, T. E. Thorpe, Thomas Tyrer, Dr. Edwin Schunck, F. Clowes and George Beilby.

CAMBRIDGE UNIVERSITY has conferred an honorary degree of Doctor of Science on William Turner, professor of anatomy of the University of Edinburgh, and on the Rev. Thomas Wiltshire, emeritus professor of geology in King's college, London.

At the annual meeting of the American Academy of Arts and Sciences on May 10, 1899, the following officers were elected: *President*: Alexander Agassiz; *Vice-President* for Class I.: John Trowbridge; *Vice-President* for Class II.: Alpheus Hyatt; *Vice-President* for Class III.: Augustus Lowell; *Corresponding Secretary*: Samuel H. Scudder; *Recording Secretary*: William Watson; *Treasurer*: Francis Blair; *Librarian*: A. Lawrence Rotch; *Member of Committee of Finance*: Augustus Lowell; *Councillors* from Class I.: Henry Taber, Theodore W. Richards, Harry M. Goodwin; *Councillors* from Class II.: Benjamin L. Robinson, William T. Councilman, John E. Wolff; *Councillors* from Class III.: Barrett Wendell, Edwin Robinson, James B. Ames; *Rumford Committee*: Erasmus D. Leavitt, Edward C. Pickering, Charles R. Cross, Amos E. Dolbear, Arthur Webster, Theodore W. Richards, Thomas Mendenhall; *C. M. Warren Committee*: Frank H. Storer, Charles L. Jackson, Samuel Cabot, Henry B. Hill, Leonard P. Kinnicut, Arthur M. Comey, Robert H. Richards.

THE following 15 candidates have been elected by the Council of the Royal Society to

recommended for election into the Society: Professor William F. Barrett, Mr. Charles Booth, D.Sc., Major David Bruce, A.M.S., Mr. Henry John Horstman Fenton, M.A., Mr. James Sykes Gamble, Professor Alfred Cort Haddon, Dr. Henry Head, Professor Conwy Lloyd Morgan, F.G.S., Mr. Clement Reid, F.G.S., Professor Henry Selby Hele Shaw, M.Inst.C.E., Dr. Ernest Henry Starling, Professor Henry William Lloyd Tanner, M.A., Mr. Richard Threlfall, Mr. Alfred E. Tutton, B.Sc., Professor Bertram Coghill Allen Windle, M.D.

DR. L. A. BAUER has resigned his position as assistant professor of mathematics and mathematical physics at the University of Cincinnati, in order to accept the position of Chief of the newly-formed Division of Terrestrial Magnetism, of the United States Coast and Geodetic Survey. To this Division has been assigned the magnetic survey of the United States and the countries under its jurisdiction and the establishment of magnetic observatories. Dr. Bauer has also been appointed lecturer in terrestrial magnetism at the Johns Hopkins University. The journal *Terrestrial Magnetism and Atmospheric Electricity*, beginning with the June number, will hereafter be issued from the Johns Hopkins University Press, Dr. Bauer continuing as editor-in-chief.

COMMISSIONER-GENERAL PECK has appointed Dr. Tarleton H. Bean Director of Forestry and Fisheries of the United States Commission to the Paris Exposition of 1900.

PROFESSOR EDGAR FRISBIE, of the U. S. Naval Observatory, having attained the age limit prescribed by the U. S. Navy, will retire on May 22d.

DR. G. LINDAU has been appointed Custodian of the Imperial Botanical Museum of Berlin.

Nature states that Mr. F. V. Bennett, who joined the Geological Survey of England in 1868, has resigned from the staff. During his long service he has mapped large areas of the Cretaceous, Tertiary and drift deposits in the eastern counties in Surrey, Berkshire and Wiltshire.

THE daily papers state that the gold medal of the American Geographical Society will be presented to Sir John Murray, the celebrated

naturalist, on the occasion of the annual meeting of the Royal Geographical Society in June. The presentation will be made by United States Ambassador Choate.

THE Council of the Institution of Civil Engineers have made the following awards for papers read and discussed before the Institution during the past session: A George Stephenson medal and premium to Mr. R. A. Hadfield, a Telford medal and premium to Mr. J. T. Milton, Watt medals and premiums to Sir Albert J. Durston and Mr. H. J. Oram, a Crampton prize to Mr. Francis Fox, a Manby premium to Sir William Roberts-Austen, and Telford premiums to Mr. J. M. Dobson, Mr. W. G. Kirkaldy and Mr. A. P. Head. The presentation of these awards, together with those for papers which have not been subject to discussion and will be announced later, will take place at the inaugural meeting of next session.

PROFESSOR CARL CHRISTIANSEN, who holds the chair of physics in the University of Copenhagen, is at present visiting American universities.

THE following officers of the Royal Institution have been elected for the ensuing year: *President*, the Duke of Northumberland; *Treasurer*, Sir James Crichton-Browne; *Secretary*, Sir Frederick Bramwell; *Managers*, Sir Frederick Abel, Sir William Crookes, the Duke of Devonshire, Lord Salisbury, Lord Halsbury, Dr. W. C. Hood, Professor D. E. Hughes, Lord Kelvin, Mr. A. B. Kempe, Mr. H. Leonard, Sir Andrew Noble, Mr. A. Siemens, Mr. B. W. Smith, Mr. W. H. Spottiswoode and Sir Henry Thompson; *Visitors*, Mr. W. H. Bennet, Mr. A. Blyth, Mr. M. Horner, Mr. E. Kraftmeier, Lieutenant-Colonel L. W. Longstaff, Mr. F. McClean, Mr. H. F. Makins, Mr. L. Mears, Dr. R. Messel, Mr. L. M. Rate, Mr. J. C. Ross, Mr. W. J. Russell, Mr. A. G. Salamon, Sir James Vaughan and Mr. J. J. Vezey.

MR. ANDREW CARNEGIE has been elected an honorary member of the American Library Association in recognition of his munificent gifts for American libraries.

MR. CHARLES LEESON PRINCE died at Tunbridge Wells on April 22d. He became a member of the Royal College of Surgeons in

1843, but ceased the practice of his profession in 1874. He was a Fellow of the Royal Astronomical and Meteorological Societies and a member of the Scottish Meteorological Society, and the author of 'Observations on the Climate of Uckfield,' second edition, 1886; 'Observations upon the Great Comet and Transit of Venus,' 1882; 'On the Ancient Telescope of Hevelius, with Translation,' 1882; 'Observations upon the Climate of Crowborough Hill, Sussex,' second edition, 1898; and 'On the Rainfall at Uckfield for 50 years.'

MR. BENJAMIN VINCENT, who was connected for more than half a century with the Royal Institution of London, died on May 3d. The *London Times* states that he owed his appointment as Assistant Secretary in 1848 to Faraday, with whom he was connected by marriage. He became subsequently Keeper of the Library, retiring in 1889 with the title of Honorary Librarian. At the Royal Institution Faraday, who was about twenty years his senior, found in him an untiring and enthusiastic coadjutor in promoting the knowledge of scientific progress and the welfare of the Institution. Faraday was well aware of the importance of creating and maintaining public interest in scientific work, and in this respect was greatly helped by Mr. Vincent, who for many years, quite apart from the official duties of his position, drew up clear, condensed reports of the lectures and discourses delivered at the Institution, which were published in *The Times*, the *Athenæum* and the *Illustrated London News*. As Librarian he was responsible for the arrangement and selection of the large and valuable collection of books, and he found time to prepare an admirable classified catalogue of these.

THE death is announced of M. M. Charles Brongniart, assistant in entomology at the Paris Museum of Natural History, at the age of 40 years. He was the son of the eminent botanist and had himself made important contributions to entomology.

DR. WILHELM JORDAN, professor of geometry and geodesy at the Technical Institute at Hannover, died on April 17th, aged 57 years.

PROFESSOR NEWTON, of Cambridge University, announces that applications by students to

occupy the University's table in the laboratory of the Marine Biological Association at mouth should be sent to him on or before June 1st.

THE Division of Forestry of the Department of Agriculture is prepared to appoint a well-qualified student assistants. They will be given practical field work, their expenses be defrayed and they will be given \$300 a year. These assistants should have preparation as follows:

(1.) Botany, emphasis to be laid chiefly on structure and life of plants. Systematic botany not be dwelt on at length. The knowledge essential to the determination of the species of trees is, naturally, of great importance. Cryptogamic botany should not be entirely neglected, although only a general view is required.

(2.) Geology, with special emphasis on the origin and meaning of the surface features of the earth.

(3.) Some physics and chemistry are essential; a slight knowledge of zoology and entomology should not be omitted.

(4.) Mathematics should include geometry, trigonometry, and, preferably, mechanics also; good working knowledge of surveying should be required.

(5.) Some knowledge of law and business methods.

(6.) German or French, preferably the former, still better both together.

(7.) A good course in economics.

(8.) History and geography of the United States with special reference to economic development and production.

Further information concerning these positions may be obtained from Mr. Gifford Pinckney, Chief of the Division of Forestry, Department of Agriculture.

By the will of Benjamin F. Horwitz, of Little Rock, \$5,000 is bequeathed to Johns Hopkins University, the income to be used annually bestowing a medal upon such member of the medical profession, either in this country or abroad, who has accomplished most during the preceding year in ameliorating the sufferings of mankind in the way of medical discovery. This bequest is in honor of the memory of Dr. Eugene Horwitz, son of the testator.

We learn from the *British Medical Journal* that by a codicil to his will, dated February

20, 1899, Sir John Struthers bequeaths to the Royal College of Surgeons of Edinburgh the sum of £500 'for the purpose of promoting anatomical science' by founding a lecture to be delivered every third year before the College, the subject of the lecture to be on any part of normal vertebrate anatomy, the lecturer to be chosen at least a year before the lecture without restriction as to country or profession. Sir John Struthers left his large and valuable stock of anatomical drawings to the University of Edinburgh for the use of the professor of anatomy in the University. Most of the drawings were made by his own hand, and many of them direct from nature. Sir John Struthers also left to the University of Glasgow the sum of £500 for the founding of an award in anatomy for the purpose of encouraging original research or special practical work, the award to be made for original research or for the best special dissections or preparations or series of dissections or preparations relating to any part of anatomy, human or comparative, the decision to rest with the professor of anatomy in the University. The award is to be made every second year and to take the form of a gold medal with money prize. The prize is to be open to all students and graduates of the University of Glasgow, including the women students and graduates of Queen Margaret College.

THE annual subscriptions promised to The Liverpool School of Tropical Diseases now amount to about £2,500.

IN June next the Royal Institution, London, will complete 100 years of its existence, the first meeting of its members in the building in Albemarle street having been held on June 5, 1799. The managers have decided that this event, so interesting and memorable in the life of the Institution and in the history of science, shall be duly celebrated, and arranged for the delivery of two commemoration lectures. The first of these will be delivered on Tuesday, June 6th, by Lord Rayleigh, when the Prince of Wales, Vice Patron of the Institution, will preside and receive the honorary members; the second of the lectures will be delivered on Wednesday evening, June 7th, by Professor Dewar, when the Duke of Northumberland,

President of the Institution, will preside. The Lord Mayor has consented to give a reception to the members and guests at the Mansion-house on the evening of Tuesday, June 6th.

PROFESSOR GUSTAVE GILSON, of Louvain University, Belgium, has begun, under the direction of the government of Belgium, a series of experiments in the North Sea. On April 29th a set of bottles was let off from the West Hindar light vessel, 2 degrees, 26 minutes east longitude, 51 degrees, 23 minutes north latitude—i. e., about twenty miles northwest of Ostend. Each bottle contains a printed card, and it is hoped that any one who picks up one of these bottles will take out the card and fill up the blanks reserved for the place and date of finding, name and place if found on the shore, latitude and longitude if found on the sea, and send it to Professor Gilson.

DR. PETERS, the German explorer, arrived at Sena, on the Zambesi, on May 8th.

THE Duke of Abruzzi started from Rome on the 2d inst. for the polar regions. His purpose is to sail from Norway for Franz Josef Land in the steamship *Star of Italy*, go as far north as possible in the ship, and then to try to reach the pole with sledges. The king and the royal princes have, it is reported, subscribed \$200,000 for the expedition, and the Duke will himself spend a large sum.

THE first statutory general meeting of the British National Association for the Prevention of Consumption and other Forms of Tuberculosis, of which the Prince of Wales is President, was held in London on May 4th. The Earl of Derby presided, and those present included Sir William Broadbent, Sir James Crichton-Browne, Sir Ernest Clarke, Sir John T. Brunner, M. P., Dr. Church, President of the Royal College of Physicians, Sir G. T. Brown, Mr. Edward Hulse, Professor McFadyean, Mr. C. Rube, Mr. Malcolm Morris, Treasurer, and Dr. St. Clair Thomson, Honorable Secretary of the Organizing Committee.

AT the annual dinner of the Sanitary Institute of Great Britain on May 2d the Duke of Cambridge, who presided, referred to the great work which it had done in promoting sanitary

knowledge. The public had made such use of the Parkes Museum, maintained by the Institute, that the Council had decided to start a building fund to provide a larger building to give the accommodation required for its increasing work. The Institute possessed 2,300 members and associates; its income last year was over £8,000, and its capital amounted to over £12,000. It had held 200 meetings, attended by 90,000 people.

UNIVERSITY AND EDUCATIONAL NEWS.

MR. ANDREW CARNEGIE has given £50,000 to the proposed University of Birmingham, on the understanding that scientific work be especially emphasized in the University, instancing Cornell University as the best model to be followed. The committee, in thanking Mr. Carnegie for this gift, state that it had always been intended that special attention should be given to scientific training and research.

MR. PASSMORE EDWARDS has given £10,000 to the new London University for the teaching of economics and commercial science. The *London Journal of Education* states that the commissioners of the University have decided to establish departments of psychology, political science and engineering.

THE will of the late Professor Marsh, leaving his property to Yale University and the National Academy of Sciences, is being contested by a nephew. It is unfortunate that such contests should be so common in the United States. It is in any case fortunate that Professor Marsh during his life devoted the greater part of his fortune to scientific work and Yale University.

THE Georgia Federation of Women's Clubs have presented a scholarship to the Teachers' College, Columbia University, of the value of \$450 a year. It will be assigned, on competitive examination, to an experienced teacher of the State of Georgia, and will be known as 'The Georgia Federation Scholarship.'

LAST year the University of Paris was given anonymously 75,000 fr. to permit five graduates to make a tour around the world. The gift has been repeated this year and increased so that each student will receive 16,500 fr. for the journey, which is expected to last two years.

NEW arrangements have been made for award of the Bowdoin prizes of Harvard University. A prize of \$300 will be offered graduates who have been in residence within three years. The subjects are to be in the languages next year, in philosophy, political science and history the following year and in mathematics and science in 1902.

The *American Naturalist* states that Gray Herbarium of Harvard University recently purchased a collection of Compositae of the late Dr. F. W. Klapp, of Hamburg, which contains about 11,000 specimens and will probably add 60 genera, 1500 species, to the Gray Herbarium, which previously contained 35 sheets of composites.

A COLLECTION from the medical library of late Dr. William Pepper, formerly Provost of the University of Pennsylvania, has been presented to the University by his son.

A COURSE in commerce, diplomacy and international law has been established at University of Pennsylvania. The course extends over two years. The subjects proposed being as follows: *First year*—American diplomacy, American commercial relations, international trade and foreign exchange, political economy, economical resources of European countries, and public finance. *Second year*—international law, European commercial relations, diplomatic history of Europe, government of colonies and dependencies, practical economic problems, economic resources of the Far East, comparative constitutional law.

MISS LILLIE J. MARTIN has been appointed acting assistant professor of psychology in Stanford University, to replace Dr. Frank Atkinson during a year's leave of absence in Europe.

MISS EDITH CHICK has been appointed Quaker student in botany for three years (£100 per annum) at University College, London.

THE professorship of pathology at St. Andrews, vacant by the removal of Professor Macleod to Glasgow, will be filled on June 21st. Information regarding the appointment may be obtained from Mr. J. E. Williams, Secretary of the University.

SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; J. LE CONTE, Geology; W. M. DAVIS, Physiography; HENRY F. OSBORN, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; J. MCKEEN CATTELL, Psychology; DANIEL G. BRINTON, J. W. POWELL, Anthropology.

FRIDAY, MAY 26, 1899.

CONTENTS:

<i>A Magnetic Survey of the United States by the Coast and Geodetic Survey:</i> DR. HENRY S. PRITCHETT.....	729
<i>The Jesup North Pacific Expedition.....</i>	732
<i>On the Brightness of Pigments by Oblique Vision:</i> PROFESSOR FRANK P. WHITMAN.....	734
<i>An Extension of Helmholtz's Theory of the Heat of the Sun:</i> DR. T. J. J. SEE.....	737
<i>On the New Genus of Lamprey <i>Macrophthalmia</i> Chilensis:</i> PROFESSOR BASHFORD DEAN.....	740
<i>Note on the Spawning Season of the Eel:</i> EUGENE G. BLACKFORD	740
<i>Evolution of the Embouchure in North American Indian Flageolets:</i> E. H. HAWLEY.....	742
<i>Scientific Books:—</i>	
<i>Angot's Traité élémentaire de météorologie:</i> DR. FRANK WALDO. <i>Collins on the Genesis and Dissolution of the Faculty of Speech:</i> E. W. T. <i>Codex Borbonicus:</i> M. H. SAVILLE. <i>Schimper's Pflanzengeographie auf physiologischer Grundlage:</i> DR. FREDERICK E. CLEMENTS. <i>Victor von Richter's Organic Chemistry:</i> PROFESSOR E. RENOUF. <i>Van Deventer's Physical Chemistry:</i> PROFESSOR HARRY C. JONES. <i>Books Received.</i>	743
<i>Scientific Journals and Articles</i>	750
<i>Societies and Academies:—</i>	
<i>The Chemical Society of Washington:</i> WM. H. KRUG. <i>The Geological Conference and Students' Club of Harvard University:</i> J. M. BOUTWELL.	751
<i>Discussion and Correspondence:—</i>	
<i>Telepathy Again:</i> PROFESSOR WM. JAMES. <i>On the Wehnelt Current Breaker:</i> HOWARD McCLENAHAN.....	752
<i>Thermodynamic Action of 'Steam Gas':</i> PROFESSOR R. H. THURSTON	753
<i>The Removal of Dr. Wortman to the Carnegie Museum:</i> H. F. O.....	755
<i>Scientific Notes and News.. ..</i>	755
<i>University and Educational News.....</i>	759

MSS. intended or publication and books, etc., intended for review should be sent to the responsible editor. Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

A MAGNETIC SURVEY OF THE UNITED STATES BY THE COAST AND GEODETIC SURVEY.

In the plan of reorganization of the 'survey of the coast,' adopted in March, 1843, explicit provision was made for magnetic observations.

Determinations of the magnetic declination were made at various points along the coast, under the superintendency of F. R. Hassler; the real work of magnetic observations, however, began with Superintendent Bache, who had previously made a magnetic survey of Pennsylvania and who had established the first magnetic observatory in this country, that of Girard College, Philadelphia.

Since that time the three magnetic elements, the declination, the dip and the intensity, have been determined by survey parties at various points in the United States, including Alaska, and in some foreign ports.

The general charge of this work, as well as the theoretical discussion which has given it value, has been in the hands of the Assistant Schott, Chief of the Computing Division, who has called attention from time to time to the need of a systematic prosecution of a magnetic survey of the country. It is largely due to Mr. Schott and his energy in that work that the present state of advancement has been reached.

In recognition of his contribution to Ter-

terrestrial Magnetism, the Paris Academy awarded him last year the Wilde prize of four thousand francs, which was personally presented by the President of the United States. This honor is especially *apropos* and particularly welcome to the friends of science in this country, inasmuch as Mr. Schott has just rounded out fifty years of magnificent work in the Survey.

With the addition of the islands of the Atlantic and of the Pacific which have come to the United States in the last year, and with the need for investigation of general laws of Terrestrial Magnetism for the whole globe, it seems that the time has now come for systematic magnetic operations, not only upon the continent of North America, but also on the islands in its vicinage. With the purpose of carrying forward such a magnetic survey and of completing in a reasonable time the collection of such data as may be necessary for a partial discussion of the problems of the Magnetic Field of the Earth, a new Division has been organized in the office of the Coast and Geodetic Survey, known as the Division of Terrestrial Magnetism. Dr. L. A. Bauer, formerly assistant professor of mathematics and mathematical physics at the University of Cincinnati, and editor of the *Journal of Terrestrial Magnetism* has been called to take charge of this new division of magnetic work.

The following general plan of work, which has been outlined as the basis for the magnetic survey of the United States and its adjacent islands may be of interest.

To indicate completely the laws which hold in the Magnetic Field of the earth, it would be desirable to have simultaneous observations at a vast number of stations over the continent of North America and of the adjacent islands. This is, of course, impossible, and the magnetic survey which must be made will necessarily depend on observations made at different times and

reduced as accurately as possible to some mean epoch. To arrive at a first preliminary result, it will probably be necessary to make a general magnetic survey of the country, observing the magnetic elements at stations thirty or forty miles apart, making these stations more frequent in disturbed areas if necessary. The secular variations will necessarily be determined by repeating the observations at representative stations as the work goes on. The areas of the countries at present belonging to the United States are approximately as follows:

United States,.....	3,025,600	square miles,
Alaska,.....	577,390	" "
Hawaiian Islands,.....	6,250	" "
Puerto Rico,.....	3,530	" "
	3,612,770	

This area is nearly equal to that of a Europe and is one-fifteenth of the entire area of the globe. As magnetic surveys have been most vigorously prosecuted in Europe, it will be of interest to note the density of distribution of the magnetic stations in two recent, fruitful magnetic surveys, viz., that of Great Britain, where there was one station to every 139 square miles, and that of Holland, embracing one station to every 40 square miles.

Suppose we were to decide upon one station, on the average, to every 100 square miles—an end that we must hope to attain some day—then we should require the determination of the magnetic elements at 30,000 stations within the United States. At the rate of 400 stations a year, the magnetic survey, as detailed as this, would require for its completion 75 years. It is not well, however, to have a magnetic survey extend over such a long interval of years. The errors incurred in reducing the observations to a common epoch would greatly exceed the errors of observation.

It is evident that we must either have a very large number of observers and instru-

ments at our disposal so as to complete the survey within a short interval, say 10 years at the most, or we must content ourselves for the present with taking a less detailed survey.

Let us say that our present means will enable us to complete 450 stations per annum, of which 400 are to lie within the United States. Suppose that at the end of the year 1910 we shall have occupied 4,000 stations in the United States and have made the necessary 'repeat observations,' and that the stations have been to some degree uniformly distributed, then we shall have on the average one new station to every 756 square miles. Selecting as the epoch to which the observations shall be reduced January 1, 1905, we should then have with the addition of about 1,000 former stations, which we could utilize, a magnetic survey, the stations of which would be distributed at the average rate of one to every 600 square miles, or, approximately, one station to an area 25 miles, 40 kilometers, square.

This will give a very satisfactory representation of the distribution of the earth's magnetism within our confines and will suffice for the accomplishment of many of the practical purposes of magnetic surveys.

We will call this our 'first survey' and, as stated, its epoch 1905. We shall now be able to tell in what portion of the country more stations are needed. That is the density of the ultimate distribution of stations will not be a uniform one. In regions where the distribution of magnetism is fairly regular comparatively few stations will suffice, while in magnetically disturbed areas the number of stations must be increased in uniformity with the character and extent of the disturbance. The subsequent work will consist then in filling in stations where most needed and repeating observations at the 'repeat stations.'

In short, the plan of conducting a magnetic survey of this country which appears

to be best suited to the present conditions, and one that is possible to carry out within a reasonably short time, is as follows: To make, first, a general magnetic survey of the country with stations about 25 to 30 miles apart; then, as opportunities present themselves, to observe more closely the magnetically disturbed areas. The observations at the 'repeat stations' made from time to time will furnish the proper secular variation corrections.

The great advantages of this plan over that of attempting a very detailed magnetic survey at once, the steady progress of which over the entire country, on account of its extent, would necessarily be very slow, will be readily perceived. The plan thus briefly outlined will make it possible within a reasonable time to construct two sets of magnetic maps for the same epoch, each set based upon a different distribution of the stations. An opportunity will thus be afforded, as in the case of the recent magnetic survey of Great Britain, to obtain some idea of the accuracy with which the iso-magnetic lines can be determined. The satisfactory solution of this question will serve as a valuable guide in future magnetic work.

Several State Geologists are making plans for detailed magnetic surveys of their respective States, in cooperation with the Coast and Geodetic Survey.

In addition to the observation of the magnetic elements at numerous points it is necessary to maintain a few magnetic observatories where continuous observations over a term of years will afford the data for comparing and reducing observations and for detecting the general changes in the earth's magnetic force. The Coast and Geodetic Survey has a number of years maintained such an observatory, for a time at Los Angeles and later at San Antonio, at which point the observations were brought to a close, as they have been in the

case of the Naval Observatory at Washington, by the interference of trolley wires.

Just what points will be chosen for the maintenance of continuous observatories will depend somewhat on the number of fixed magnetic observatories already maintained by universities and other institutions. With continuous records in Washington, Toronto, one point in the Northwest, Mexico and Havana, the magnetic fluctuations over the continent of North America ought to be fairly well followed. In addition to these a magnetic observatory will be established by the Coast Survey on one of the Hawaiian Islands, where its situation will not only supplement the data furnished by the observatories in the mainland, but by reason of its position in an isolated island may well be expected to add new facts to our knowledge of one of the most interesting, but one of the least perfectly understood, branches of physical science.

HENRY S. PRITCHETT,
Superintendent.

*THE JESUP NORTH PACIFIC EXPEDITION.
ETHNOLOGICAL WORK ON THE ISLAND OF
SAGHALIN.**

THE following report has been received from Dr. Berthold Laufer, who is in charge of the ethnological work of the Jesup North Pacific Expedition on the Amoor River and on the Island of Saghalin. The expedition is being carried on under the auspices of the American Museum of Natural History, the expenses being borne personally by President Morris V. Jesup. Dr. Laufer left New York in May, 1898, and went to Saghalin by way of Japan and Vladivostok. He spent the time from the summer of 1898 until March, 1899, among the various tribes inhabiting that island. He writes under date of March 4, 1899, as follows:

* Published by authority of the Trustees of the American Museum of Natural History.

In the collections which I made on the Island of Saghalin there are a number of very interesting specimens. On my journey made in the course of last winter I succeeded in obtaining from the Olcha Tung a collection of wooden idols and amulets made of fish-skins, which are quite new to science. I obtained from the Ainu on southern Saghalin a very interesting collection of ethnographical objects. I have had very good success in using the phonograph, and have obtained songs of the Gilyak and Tungus. The only difficulty is that the instrument cannot be used in the winter, owing to the effect of severe cold.

I intend to leave Saghalin the beginning of next week and continue my work on the Amoor River. It is my intention to devote a good deal of my time to the study of linguistics, since this part of my investigations has been least satisfactory. There are no interpreters on Saghalin capable of translating texts. There is no one who knows more than the most common phrase of Russian. Among the Ainu, Russian is entirely unknown, and for the purpose of interpreting I had to use Japanese, with which, however, they are not very familiar either. My knowledge of the Japanese language facilitated my work among them very much, since they like the Japanese very well. I succeeded in obtaining a great deal of ethnological material and information, traditions, and a large amount of grammatical and lexicographical material, although a short time only was available for this purpose. I collected most of my material among the Ainu during the night time, because it is only at this time that everything is at rest. I have no detailed translations of this material, but expect to be able to make translations with the help of my lexicographical material and comparisons with the Ainu dialect spoken in Japan. There is a great difference between these two dialects. The Ainu of

Yezzo have a vigesimal numeral system, while those of Saghalin have a purely decimal system. The latter dialect is much more archaic. Its morphology and phonetics are richer. I have also found the pronominal prefixes recently discovered by Bachelor. I am well satisfied with the results of my ethnographical researches among these people. I have obtained full explanations of their decorative designs. I did not succeed in obtaining any measurements. The people were afraid that they would die at once after submitting to this process. Although I had their full confidence, I could not induce them to submit, not even by offering presents which they considered of great value. In Korsakovsk I succeeded in measuring a single individual, a man of imposing stature, who, after the measurements had been taken, collapsed and looked the picture of despair, groaning, "Now I am going to die to-morrow!" The opinion that the Ainu are exceedingly hairy is decidedly exaggerated, at least so far as Saghalin is concerned. I have seen almost every single individual of the villages of the east coast of the island; and as I slept in their huts I had ample opportunity of seeing naked individuals, since they undress in the evening. By far the greater number of the men whom I have seen have no hair on their bodies, or at least no more than is found among Europeans. A more considerable amount of hairiness on chest and arms I have seen only in a few old men. Neither is the long beard characteristic of all Ainu. There are just as many with long beards as there are with short beards, or even without beards. I do not think that their type is homogeneous at all. I do not understand the reasons for Schrenck's statement that it is impossible to distinguish a Gilyak from an Ainu. It seems to me they may be distinguished with certainty, even from a long distance. I have no doubt that the information that I have

collected on this island contains a very considerable amount of what is new. There are a great many errors in Schrenck's descriptions of the tribes of Saghalin. The Orok tribe, to which he refers, does not exist.

I started comparatively late on my journey along the east coast, because I was detained for two months and a-half by a severe attack of influenza. As soon as I had sufficiently recovered I went to Rykovsk, where the Gilyak were celebrating one of their bear festivals. I was welcomed with much delight, since I met several of my acquaintances of last summer. For five days I witnessed the ceremonial, and was even permitted to see the sacrifice of the dog, which is kept secret from the Russians. Then I travelled southward a hundred versts on horseback to Kasarsk, the southernmost Russian settlement on the central part of the island. I visited the whole valley of the Poronai as far as the mouth of the river on a reindeer sledge, and stayed for some time in the large Tungus village Muiko, where I had the great pleasure of obtaining additional information in regard to the texts which I had recorded during the preceding summer. I have measured almost the whole population of this area and collected statistical information. In this valley there are a number of Gilyak families who have begun to use the reindeer. I had also an opportunity of seeing a few Yakut. In December I reached Tichmenevsk, which is called Siska by the natives. This place is situated on Patience Bay. On the following day I started on an excursion eastward, in which I was particularly fortunate and successful. I obtained many specimens and much information on the Shamanistic rites and the ceremonials of the natives. When, later on, I had an opportunity to show my specimens to some Russians they were much surprised, since during the many years of their life on

Saghalin they had not seen anything of the kind. Then I visited the villages Taran-kotan and Taraika, where I first fell in with the Ainu. I also visited the Tungus villages Unu, Muiko and Walit, after having passed the famous lake of Taraika. It was impossible to proceed farther eastward, since I received an official letter of warning not to proceed, because a few versts farther east a band of highwaymen consisting of escaped convicts had built a fort and were terrorizing the country. For this reason I returned without making the acquaintance of these gentlemen.

On New Year's Eve I reached Siska. On the following day I took phonographic records of songs, which created the greatest sensation among the Russians as well as among the natives. A young Gilyak woman who sang into the instrument said: "It took me so long to learn this song, and this thing here learned it at once, without making any mistakes. There is surely a man or a devil in this box which imitates me!" And at the same time she was crying and laughing from excitement.

On the second of January I started by dog-sledge for Naiero, where I had the best results in my work with the Ainu. Then I visited all the settlements on the coast as far as Naibuchi, which is 260 versts from Siska. This journey was exceedingly difficult, and sometimes even dangerous. At one time I narrowly escaped drowning when passing the ice at the foot of a steep promontory. I broke through the ice, which was much weakened by the waves. Fortunately, my guide, who was travelling in front of me, happened to capsize on his sledge at the same moment when I broke through. Thus it happened that he saw my situation and extricated me with his staff.

Towards the end of the month I arrived at Korsakovsk, making the distance from Naibuchi, about 100 versts, on horseback.

Originally I intended to return from this point along the west coast of the island but this proved to be impossible, as there is no means of communication in winter. For this reason I had to return northward the same way by which I came, and I had to travel as rapidly as possible in order to reach Nikolaievsk in time. Towards the end of March communication between the island and mainland over the ice is suspended. Therefore, I returned with all possible speed; working and collecting, however, when opportunity offered. The last few days I travelled day and night, camping a few hours, but not more than necessary to give the reindeer time to rest. At nine o'clock this morning I arrived here, having covered, since six o'clock yesterday morning, a distance of 200 versts.

ON THE BRIGHTNESS OF PIGMENTS BY
OBLIQUE VISION.*

In the formation of any theory of color-vision the phenomena of color-blindness necessarily play an important part. This is especially true, of late years, of total color-blindness, or the absence of all color-sense. Of this phenomena there are three classes exemplified by the eyes of those rare individuals who lack from birth all power of perceiving color by the normal eye in faint light and by the peripheral vision of the normal retina.

In each of these three cases the spectrum appears as a colorless band of graduated brightness. It was pointed out by Hering, in 1891, that the distribution of brightness in the first two of these three classes is the same, and it has been generally supposed that the color-blindness of the retinal periphery is of similar character. Von Kries showed, however, that this supposition was untrue (*Zeitschr. für Psychologie und Phys-*

*A paper read at the Boston meeting of the American Association for the Advancement of Science, August, 1898

iologie der Sinnesorgane, XV., pp. 247-279, 1897), the maximum brightness for peripheral as for direct vision in bright light being in the yellow, and not, as in the other two classes, in the green.

According to the theory of Von Kries the visual mechanism used in bright light differs entirely from that used in faint light. The former distinguishes colors as colors, and finds the greatest brightness in the yellow of the spectrum, but requires a certain intensity of illumination before it can act at all. The other is insensible to color, seeing the spectrum, as stated above, as a strip of varying brightness, with its maximum in the green. As one who is born totally color-blind sees the spectrum in the same way, von Kries argues that in this case the 'brightness-apparatus' is absent or ineffective, and that vision is due entirely to the 'twilight-apparatus,' which in the normal eye becomes important only in faint light.

On the other hand, he goes on to say, the periphery of the normal eye acts "not (as the totally color-blind eye) by means of an absence of the 'brightness-apparatus,' and an exclusive use, therefore, of the 'darkness-apparatus,' but through a limitation or change in the functions of the 'brightness-apparatus.' In the language of the anatomical hypothesis, we must assume that even in the periphery of the 'brightness-adapted' eye the cones play the most important part, and that the color-blindness arises from a functional modification of the apparatus depending mainly on these elements, the 'brightness-apparatus.' This view is supported by the fact that the periphery values show approximately the same relations in the distribution of brightness as the color-perceiving portions of the eye, with the maximum near the sodium-line."

As this question is of considerable importance in the theory of color-vision, it seemed worth while to re-examine it with

the flicker photometer, an instrument which appears excellently adapted to such a purpose. Its value in the study of ordinary color-blindness was pointed out by the writer in a paper read at the Detroit meeting of this Association, and Professor Rood, working with a flicker instrument of an entirely different type, has come to the same conclusion. The flicker photometer is also peculiarly adapted to the study of peripheral vision, since, as is well known, the peripheral regions of the retina are especially sensitive to appearances of motion or of changing brightness.

The instrument used in these experiments was of the revolving-disk type already described by the writer (*Physical Review*, Vol. III., No. 16, Jan.-Feb., 1896). To this instrument the arc of a circle was attached, the center of which was as nearly as possible the place occupied by the eye in front of the observing tube. This was marked in three points, at 30, 50 and 70 degrees from the line of direct vision. When the eye was directed on one of these marks observations with the sight tube could be made at the corresponding obliquity. All observations were made in a horizontal plane on the nasal side of the retina.

The conditions were those of ordinary photometric observation; the room was dark and the eye screened from any light except that under observation. Thus the eye was, without doubt, partially 'adapted for darkness,' though the lights under observation were too bright to allow this adaptation to go very far. The sources of light were kerosene lamps, provided with Methven slits and burning a special high-grade oil. They were found to burn with great uniformity, but were checked by frequent direct observations. The right-hand lamp was used as a standard, was kept always in one place, and used to illuminate the revolving disk. The left-hand lamp illu-

minated the pigments to be studied, and could be moved along the bar. All colors were brought to the same intensity before observations, that is, the photometer, containing the colored card, was set at a definite distance from the right-hand lamp, and the other lamp moved backward or forward until a balance was approximately attained. It was left in this position, and the set of observations on any given color made by moving the photometer head in the usual way. Thus the uncertainties were avoided which arise from working with lights of small intensity.

Six colored papers were selected from the set published by the Milton Bradley Company—red, orange, yellow, green, green-blue, blue. Each of these was examined by direct vision, and at each of the three angles before mentioned. Two concordant series of observations, each involving a large number of readings, were made on different days, and the mean of the two series taken as the final result. It soon became evident that the pigments at the red end of the spectrum decreased in brightness from the center to the periphery of the retina, while those nearer the blue end increased in brightness. It seemed probable that some color must exist for which the brightness would be the same for all parts of the retina, and to locate this color more closely the intermediate pigments yellow-green and green-yellow were added to the set originally selected. The results are exhibited in Table I.

TABLE I.

	0°	30°	50°	70°
R.	.238	.128	.089	.079
O.	.603	.297	.227	.225
Y.	.902	.755	.674	.660
G.Y.	.602	.544	.503	.506
Y.G.	.463	.466	.459	.478
G.	.292	.347	.376	.391
G.B.	.245	.317	.329	.343
B.	.107	.151	.175	.193

It is shown by this table that the yellow-

green remains nearly at the same brightness for all angles of vision; that, in fact the brightness curve for the whole set of pigments might almost be said to rotate about this color as an axis, the red falling and the blue rising as the periphery is approached. The character of the change is perhaps, more clearly shown in Table II, which is derived from Table I. by multiplying each series of figures by a factor which brings the yellow-green value to unity, changing all other results in like proportion. The value for any color at any angle of vision may then be directly read as a percentage of the value for yellow-green.

TABLE II.

	0°	30°	50°	70°
R.	.514	.275	.194	.165
O.	1.303	.637	.495	.471
Y.	2.070	1.620	1.468	1.381
G.Y.	1.300	1.167	1.096	1.057
Y.G.	1.000	1.000	1.000	1.000
G.	.631	.720	.819	.818
G.B.	.529	.680	.717	.717
B.	.231	.324	.381	.404

It is thus seen that while the red falls in peripheral vision to about one-third of its brightness when viewed directly, and blue is nearly doubled in brightness, yellow is reduced in brightness by about one-third, and yellow-green, that portion of the spectrum where we should expect the greatest brightness if the peripheral color-blindness were of the same character as 'twilight' color-blindness, remains practically the same at all angles of vision. Yellow is still the brightest of the colors, and the maximum is shifted but little toward the blue.

It is to be noted, also, that there is comparatively little change from 50° of obliquity outward. At 50° most colors are still distinguishable; at 70°, none of them. At 50° the apparatus which gives us the sensation of color must still contribute its quota to the sensation of brightness, as in

direct vision. It is probable, therefore, from the similarity of the results at the two angles, that it continues to do so in the more peripheral parts of the retina, although it has lost its other function, of color-sensation.

The results at 70° confirm in a general way the measurements of von Kries. His results are given in Table III., with the column for 70° from the flicker experiments, both also reduced to the value unity in the yellow for purposes of comparison.

TABLE III.

	VON KRIES.		WHITMAN.	
	Original Values.	Reduced.	Original Values.	Reduced.
R.	1.35	.199	.079	.130
O.	4.03	.594	.222	.337
Y.	6.78	1.000	.660	1.000
Y.G.	.....	.....	.478	.724
G.	4.92	.726	.391	.592
B.G.	3.87	.571	.....	.....
G.B.	.....	.....	.344	.521
B.	.....	.....	.193	.292
V.	.86	.127	.....	.....

The two sets of measurements, though differing considerably in detail, show a progression in brightness of a similar character, especially as to the position of the maximum. An inspection of the table makes it evident that differences in the results might possibly be explained by the assumption of slight differences in the pigments used by the two observers; but it is perhaps more probable that the difference is a real one, caused by the fact that my observations were made in a darkened room, and, therefore, with an eye more 'adapted for darkness' than that of von Kries, who worked in a well-lighted place.

While it appears evident, as von Kries holds, that the color-perceiving apparatus is of importance in determining the brightness of any color peripherally seen, it is plain that—in the language of his theory—the apparatus for twilight vision plays a more important part than in the central

portions of the retina. For the diminution of the reds and increase of the blues in brightness are characteristic only of faint illumination by direct vision—illumination fainter than the lowest at which the flicker method can be advantageously used (*Physical Review*, *loc. cit.*, p. 247), whereas they are shown by these experiments to exist in the outer regions of the retina under conditions of considerable brightness.

It may be said, in conclusion, that the brightness-sensation of the retinal periphery, so far as it differs from that of the central portions, differs from it in the same direction, though not so greatly, as in the other two types of complete color-blindness.

FRANK P. WHITMAN.

ADELBERT COLLEGE.

AN EXTENSION OF HELMHOLTZ'S THEORY OF THE HEAT OF THE SUN.*

ON the occasion of the Kant Commemoration at Königsberg, February 7, 1854, Helmholtz delivered an address on the 'Interaction of Natural Forces,' in which he laid the foundation of the modern theory of the sun's heat. The whole address, with the principal formulæ by which the numerical results were obtained, was translated into English and published in the *Philosophical Magazine* for 1856. In this paper the author discusses the conservation of energy, which he had been so instrumental in establishing upon a sound mathematical basis; and ascribes the maintenance of the sun's heat to the potential energy given up by the particles in descending towards the center of his globe. On the hypothesis that the solar sphere is of homogeneous density he subjects the problem to computation, and finds that the heat developed by a very small shrinkage of the mass will be sufficient to

* Read before the Philosophical Society of Washington, May 13, 1899.

account for the observed radiation. His principal conclusions may be summarized as follows :

1. That a shrinkage in the radius of 35 meters per year will generate sufficient heat to sustain the annual output of radiant energy.

2. That on this basis the radius of the sun would not shrink more than $\frac{1}{100000}$ part in 2,000 years, and this shrinkage could not be detected by any measurements which have been made within historical time. For the mean value of the sun's radius is about 961 seconds of arc, and is still uncertain by about one-half second ; $\frac{1}{100000}$ of this radius is thus but one-fifth of the outstanding uncertainty in the sun's semi-diameter, in spite of all the labor which has been spent in finding its exact value by refined measurement. As the diameters noted by the ancients are much less accurate than those which can be inferred from the recorded duration of ancient eclipses in conjunction with the theory of the moon, we can only say that there is no evidence that the radius has diminished since the earliest ages. Even with the finest measurements now available, it would take ten thousand years for the shrinkage to become clearly sensible. There is, therefore, little hope that the shrinkage of the sun can ever be observed, yet from known mechanical laws we may confidently compute its amount, with even greater accuracy than we could hope to obtain from direct measurement.

3. That all the energy generated in the mass of the sun by the falling together of its particles would suffice to raise an aqueous globe of the same mass to a temperature of over 27 million degrees Centigrade. Pouillet estimated from experiments on solar radiation that the heat annually lost by the sun would raise the temperature of such a globe 1.25° C. On this basis the observed radiation of the sun could not

have gone on uniformly in the past more than about 22 millions of years. . . more modern estimates increase the observed radiation appreciably, when full account is taken of atmospheric absorption we shall adopt 18 million years as the probable duration of the sun, on the theory of uniform radiation and homogeneous density assumed by Helmholtz.

4. Helmholtz further shows that all the energy given up by the condensation of the several planets amounts to but little more than $\frac{1}{100000}$ part of that developed by the condensation of the sun, and that the energy of the motion of the planets amounts to only $\frac{1}{447}$ of that resulting from the potential of the homogeneous sun upon itself. Thus nearly all the energy of the solar system has resulted from the condensation of the solar mass.

I propose this evening to present the results of a determination of the potential of the sun upon itself, when the mass is heterogeneous, or made up of successive layers of a uniform density, and the density follows the laws found by our countryman, Lane, just 30 years ago, for a gaseous body in convective equilibrium. The density of each layer can be found from Lane's theory. Beginning at the center and proceeding outward, we can thence determine the average density of the included spheres when successive layers of known density are added. (The speaker here explained the theory of the integration which he had developed, and said that the mathematical discussion of the process would appear in the *Astronomische Nachrichten*.) From an astronomical point of view the problem to be solved is best treated by some process of mechanical quadrature ; and accordingly I have divided the radius into 40 parts, and by successive steps obtained an integral for the potential of the heterogeneous sphere upon itself, which is almost rigorously exact. It turns out that the condensation of the heterogeneous sun

has produced more heat than the homogeneous one, in the ratio of 176,868 to 100,000. As the energy of condensation of the homogeneous sphere represents a radiation of 18 million years, the potential of this heterogeneous sphere would, on the same basis, sustain radiation almost exactly 32 million years. Thus the effect of most of the particles of Helmholtz's homogeneous sphere falling towards the center to produce the heterogeneous sphere here treated is to *prolong the life of the sun through an additional period of 14 million years.*

It has been generally held by those who have studied the theory of the sun's energy that this fiery globe can hardly continue its activity after the diameter has shrunk to one-half its present value, which would increase the average density of the sphere eight times, and make it equal to 11.2 that of water. *If this supposition be admitted, it will follow that our sun has a total longevity of thirty-six million years, of which thirty-two millions lie in the past and only four millions are available for the future life of the solar system. Thus eight-ninths of the available potential energy of the sun has been spent, and only one-ninth is available for future use.* This conclusion is based upon the assumptions: (1) That the sun's mass is gaseous and the density follows the laws found by Lane; (2) that shrinkage will essentially cease when the globe has attained the average density of 11.2; (3) that the ratio of the specific heat of the solar gas under constant pressure to that of the gas under constant volume is 1.4, as in common air and most terrestrial gases, and, moreover, that the average specific heat of the sun's mass is not enormously great, so that the latent heat of cooling would become a great source of energy after shrinkage had entirely ceased. All these hypotheses are extremely probable, and the first two will hardly be questioned by any one. For since Wilson and Gray (*Phil. Trans.*, 1894) find by ex-

periment that the effective temperature of the photosphere is about 8,000° C., it will follow that the temperature of the body of the sun is very much higher. According to Lane's theory this would make the temperature of the nucleus about a quarter of a million degrees Centigrade. The matter composing the body of the sun is much above the critical temperatures of all known substances, and thus is necessarily in a gaseous state, though in the nucleus it may be so far condensed, under the enormous pressure to which it is subjected, as to act like a solid or fluid of great viscosity. On the other hand, even though the central density be 28 times that of water, while the photosphere is rarer than the terrestrial atmosphere, it is hardly conceivable that appreciable shrinkage can go on after the average density of the globe has increased to eight times its present value. For the resistances due to molecular repulsive forces must tend to overcome gravitation pressure, and thus render further contraction impossible. If this state be not fully realized when the sun's radius has sunk to one-half its present value, it must yet be so fully attained in the greater part of the body of the sun that what further shrinkage is possible in the external layers will produce little available energy for maintaining the sun's heat.

As to the average specific heat of the sun we can only say that water has the greatest specific heat of all known terrestrial substances, and it is not probable that the average specific heat of the dense gases composing the sun can be enormously greater than that of the specific heats of the corresponding gases found upon our earth. Thus it is not likely that our sun can long maintain its radiation after shrinkage has ceased.

From this investigation it seems that the future duration of the sun's heat can hardly exceed four million years, and a corre-

sponding limit is set for plant and animal life upon our globe.

T. J. J. SEE.

U. S. NAVAL OBSERVATORY, WASHINGTON, D. C.,
May 12, 1899.

ON THE NEW GENUS OF LAMPREY, *MACROPH-*
THALMIA CHILENSIS.

THE preliminary account of Dr. Plate's remarkable discovery published in the *Sitzungsberichte der Gesellschaft Naturforschende Freunde*, Berlin (1897, No. 8, pp. 137-141), has, as far as I am aware, received no comment in recent literature, although there can be little doubt that this remarkable Cyclostome has revived more of the important discussions as to the position of the Cyclostomes than any publication since the time of the classic pamphlet of Professor Dohrn, '*Der Ursprung der Wirbelthiere*.' And morphologists will, I am sure, await impatiently a further discussion of the anatomy of this newly discovered type, shortly to appear in the *Fauna Chilensis* in the Supplement Volume of the *Zoologische Jahrbücher*.

As the preliminary account is not readily accessible, it may be noted that this remarkable lamprey has large and normally developed eyes. It measures but 107 mm. in length, is of a brilliant silver-white color, and its sides are literally compressed, as in the case of many of the typical bony fishes. The back region is blue-black, with light yellow, dusky flakes on the anterior half of the forehead. It is also noteworthy that the sides of the body are perfectly smooth, lacking the markings of the muscles, common in other Cyclostomes. The nasal opening is slit-like, situated anterior to the eyes, and not opening in a papilla. The gill-slits are vertically compressed. The eye is of extraordinary size, 2.5 mm. in diameter, and resembles outwardly the eyes of a Teleost, with a circular pupil, 1 mm. in diameter.

The dentition is relatively simple, and is said to resemble that of *Myxine*.

Plate has not as yet expressed his opinion as to the significance of his morphological prize; but, judging from a single phrase in his paper, he appears to regard it as a form which has not assumed parasitic habits, and has, therefore, not been subjected to degeneration. To what degree, however, will he support Dohrn's earlier teachings, which derived the Cyclostomes from a teleost-like ancestor? In any case, this discovery will by no means simplify the difficult problem as to the relationships of the Cyclostomes in general, for it is not unnatural to assume that if one of these forms has evolved normally developed eyes probably the others also may originally have possessed them, and that the present condition of cornea, lens and retina may reasonably be interpreted as degenerate instead of primitive. On the other hand, as far as the preliminary account enables one to judge, it is also possible to assume that under favorable conditions the Hyperoarte may have become highly specialized to the degree, indeed, of acquiring a more teleost-like body form, together with more completely developed visual structures. It is to be hoped that Dr. Plate has succeeded in collecting material which will throw light upon the relations of this new type from the standpoint of metamorphosis and embryonic development.

BASHFORD DEAN.

NOTE ON THE SPAWNING SEASON OF THE
EEL.

THE recent and most interesting work of the Italian naturalists Grassi, Calandruccio and Ercolani has added, in all essential regards, the needed information regarding the spawning time, as well as the metamorphosis, of the eel. I do not find, however, in my review of the literature, any definite observations with regard to either

time or place of spawning of the eel in American waters, and I wish, therefore, to present a brief note on the only instance of a spawning eel which has, up to the present time, come within my notice. I had hoped to give further instances relating to this matter, but I have, unfortunately, been unable to secure additional data.

The general interest I have always had in the spawning of the eel has led me, from time to time during the past twenty-five years, to examine the condition of the ovary in numbers of specimens which have been brought to the New York markets during various seasons. The eggs which I have, however, noticed in this material were never larger than some which I observed twenty years ago in the so-called 'eel-fat,' that is to say, minute ovarian eggs, measuring possibly .03 mm. in diameter. It has long been known, in a general way, that in this neighborhood the eels are usually taken in great numbers during November and December, at the time of their passage seaward down the Hudson or in Gravesend Bay; and it has always been supposed that the spawning takes place within a month or so of this time, since in the early spring the elvers (*montées*), which ascend the rivers, are found never measuring less than two inches in length. That the actual spawning-time, however, may be a much later one, seems to me now more than probable for the following reason: On May 8, 1898, my attention was brought to an eel containing ova which separated readily from the ovary and filled the cavity of the abdomen, and I am able to give the following notes relating to this very unusual specimen. I find it was taken at Atlantic Highlands by Lewis Morris, in relatively shallow water, between two and three fathoms, in a locality which is well known as an eeling ground. The color of the specimen was relatively bright, but not unusually so, nor was the eye notably

larger than in similar specimens from the same locality. The specimen was relatively small, measuring 42 cm. in length, and weighed but 135 grammes. The eggs are .4 mm. in diameter. A microscopic examination of the ova made by my friend, Professor Dean, of Columbia University, shows that the germinative vesicle is clearly defined, and that the egg is all but mature. The ova, as I have already noted, are readily shaken free from the ovarian tissue.

The distinct interest of this observation appears to be this, that the eel may, in exceptional instances at least, ripen its eggs in relatively shallow water, possibly in the inlets of many of the bays and sounds, instead of at the great depths which the European observers have hitherto regarded as necessary for sexual maturation. As far as I am aware, the only instance of the taking of a sexually matured eel has been in waters of one hundred or more fathoms in depth. In all these instances, moreover, the female eel has been of considerable size, at least half again as large as the present example.

The present specimen, moreover, gives us a clue to the spawning time of the eel in our neighboring waters; in any event, it demonstrates that here the season of ovulation, during the month of May or thereabouts, is certainly many months later than in the Mediterranean, for in the latter locality, according to Grassi and Calandruccio (*Fischerei Zeitung*, XXII., 428), the eggs can only be found between the months of September and January. I should note, however, that the possibility is not excluded that the present eel was of exceptional sexual characters, like the small examples of shad showing almost ripened eggs which are sometimes taken one and even two months in advance of the regular 'run.'

EUGENE G. BLACKFORD.

*EVOLUTION OF THE EMOUCHURE IN NORTH
AMERICAN INDIAN FLAGEOLETS.*

INSTRUMENT No. 76,164 in the U. S. National Museum, from the Cocopa Indians, is made of cane. The septum of the reed is not removed, but two small holes are burnt into the cavity, one on either side of the septum and the wood between the holes removed. By covering the upper hole and the intervening space between the holes with the finger and blowing in the upper end of the reed, a proper direction is given to the breath against the outer edge of the lower hole and a whistling sound is produced. Finger holes in the section below the septum enable the player to produce a variety of sounds.

The second step in the development of the embouchure is illustrated by instruments Nos. 107,535 from Tucson, Arizona, and 11,314 from the Apache Indians, in the same Territory. Both have the same style of embouchure as the first named. But a piece of cloth or deerskin tied over the upper sound hole and the space between the holes takes the place of the finger in directing the breath. It may be noticed that in none of the flageolets mentioned has the maker sharpened the edge of the lip or hole against which the wind impinges.

The third step is marked by instruments with a thin edge on the lip where the sound is made. In No. 8,429, from the Ree Indians, one section of quill is used to replace the finger or cloth in directing the breath, and another to form a sharp lip, and they are lashed down tight with sinew. In Nos. 72,884 and 94,005, from the Creek Indians, and in many other examples, the reed is replaced by a piece of soft wood split and hollowed to imitate the interior of the cane flageolet, and the pieces then joined with gum and thongs. In these the 'languid,' or languette, is left in the carving and the sound holes are united by an excavation as in 1 and 2. The air

channel is formed by excavating a shallow notch in the upper edge of the diaphragm or 'languid;' the lip being a thin piece of metal; the cover is a piece of wood, laid on and fastened with thong. This is usually carved and is a prominent feature in this style of flageolet commonly called 'courting flutes.'

The fourth and last step in this evolution is exemplified by No. 23,724, from the Siou of Devil's Lake Agency. The air passage between the two sound holes is not cut out of the diaphragm between, but a metal plate extends over and beyond both holes, and there is a rectangular slot cut out of the metal long enough to expose both holes and of the same width as the holes. The carved cap is lashed on top of the metal plate so as to form the air passage, which is bounded by the diaphragm, the edges of the metal and the underside of the wooden cap.

The Ree specimen, No. 8,429, shows that the Indian flageolet was in use before the knowledge of the Europeans. This specimen consists of a tube of hard wood. Instead of making the embouchure like those in European whistles and flageolets, placing a plug with an air channel between it and the wall of the tube just above the sound hole, they have made a long hole or slot in the wall of the tube and plugged the bore, with the gum or wax so placed that the slot is open above and below the plug. This plug, or 'languid,' is not quite even with the outer surface of the tube; the upper portion of the slot is covered with a split quill, its lower edge being even with the lower face of the plug, or 'languid,' and the shallow space between the edge of the plug within the slot and the quill forms the air channel which directs the wind against the edge of another split quill lashed over the lower part of the slot to within a quarter of an inch or so of the upper quill, thus forming a modification of the Indian cane flageolets, but not of the European form at all.

This peculiar style of the Indian flageolet I have not met with, except among the Indians of the United States, and those chiefly west of the Mississippi. There are whistles made of bone, stone or other materials by the Indians of the United States which are of the European character and they may have been known before the coming of the Europeans. But the peculiar construction of the flageolet I have described is so different from the common form that I have no doubt of its entirely Indian origin.

E. H. HAWLEY.

SCIENTIFIC BOOKS.

Traité élémentaire de météorologie. Par ALFRED ANGOT. Paris, Gauthier-Villars. 1899. Pp. vi + 417. Price, 12 francs.

Professor Angot occupies the position of meteorologist to the French Bureau Central Météorologique, and is so well known to meteorological workers the world over, that a formal treatise from his pen will receive careful consideration. It is not too much to say that Angot is to-day the foremost meteorologist in France, and as such his treatise will be considered an authority in his own country. The question naturally arises: Does the book represent the meteorology of to-day?

The author in his preface explains that he is not giving a complete treatise on meteorology, but merely a non-mathematical presentation of the elements of the science. The subject of meteorological instruments and their use has been excellently presented by the author in his 'Instructions météorologique,' and he has omitted this from his present treatise; thus having more space to devote to the results of meteorological observations and theories.

Professor Angot remarks that little attention is paid to instruction in meteorology in the institutions of learning in France, and he refers to the contrast existing in the United States, where 'a great number of special chairs are devoted to meteorology in the high schools as well as in the universities.' I must say that I am surprised to learn of this activity in the study of meteorology in our country, for my

own observation has revealed an almost utter indifference, in fact the indifference which comes from ignorance, to the claims of meteorology on the part of those who have the say of what shall and what shall not be taught in our schools and colleges. If there is any institution in the United States, except Harvard University, that devotes \$500 a year to meteorological instruction I have not yet heard of it; and, looking at the matter from another point of view, it may be remarked that our publishers who have brought out works on elementary meteorology express a disinclination to have their fingers burned by a repetition of the experiment.

Angot has divided his work into five books, which follow a brief introduction. Book I. treats of the Temperature; Book II. of the Atmospheric Pressure and Wind; Book III. of the Water in the Atmosphere; Book IV. of the Disturbances in the Atmosphere; Book V. of the Forecasting of the Weather and Meteorological Periods.

In the introduction the author explains the derivation of average values, the various periodic changes which occur in meteorology and the significance of interpolation.

Under the heading Temperature there is given first an excellent chapter on actinometry, which is followed by the usual treatment of the periodic diurnal and annual changes of temperature, and their variations with change of altitude, latitude and continental or oceanic surroundings, and the distribution of temperature over the earth's surface. An unusually full section treating of the influence of temperature on vegetation, and a quite lengthy chapter on the temperature of the soil and water surface closes this book. The charts representing the geographical distribution of the temperature (and the other elements) show the convergence of the meridians, and are consequently an improvement on the ordinary Mercator's projection.

The treatment of the barometric pressure is especially full as regards the diurnal variation; and, as was to have been expected, the cause of the semi-diurnal oscillation is referred to as still unknown.

The general conceptions concerning the direc-

tion, force and velocity of the wind are fully explained, but it is not until the author reaches the subject of the causes of the wind, and its relations with the temperature and pressure, that the reader's greatest interest is aroused. For it is here that the modern aspect of meteorology really begins, and it is just here that the author encounters his greatest difficulties. He gives first the cause and maintenance of fluid motions as depending on the differences of pressure at the same level, and establishes the complete circuit of such movements of the air; he then proceeds to explain the meaning of the terms *isobaric lines* and *barometric gradients*. Then follow, in succession, the influence of the earth's rotation on the movements of the air, the curve of inertia, the formation of cyclonic and anti-cyclonic whirls, and the circulation of the air around centers of warm or cold air. After this comes the general circulation of the atmosphere; the constant winds, the 'Trades;' the seasonal winds, the monsoons; the diurnal winds, the land and sea breezes, mountain winds, etc.

I must confess to a feeling of disappointment upon reading this part of Professor Angot's book. I had hoped that he would have given us a simple, clear, logical development of the air circulation somewhat after the manner of Ferrel's theory, but which should include the views of the best European investigators. That is what we need; but the author has contented himself with the older method of a disconnected treatment of the different features of the atmospheric circulation, some of which have been treated in one way and some in other ways by the various investigators who first developed them. I think that all of those who have tried to present in an elementary manner the results of the later investigators concerning the 'circulation of the atmosphere' have attempted an impossible short cut in meteorological literature, and that there must first be written an advanced treatment of the subject, which can later be simplified for an elementary treatise. Until this elaborate treatise has been written I think that Ferrel's development of the subject as given in his 'Popular Treatise of the Winds' (New York, 1889) will still remain the best for presentation to the student or general reader. We must bear in mind that Ferrel preceded

this popular exposition of the subject by a highly technical 'Recent Advances in Meteorology.'

In Angot's chapter on atmospheric humidity the sections on condensation and clouds deserve special mention, and the reproduction of cloud photographs are unusually good. Under rain fall the charts showing the continental distribution of this element are valuable.

The subject of meteorological optics is really too difficult for presentation in a very elementary treatise on meteorology, but the author has succeeded rather better than is usual in his brief treatment of the subject.

The development of the subject of cyclones thunder-squalls and spout phenomena is very full; but Faye's theories are given perhaps undue prominence from the German and American points of view.

In this, as in other recent treatises, the subject of Weather Predictions has not the space devoted to it which its practical importance demands.

The last chapter takes up briefly the meteorological periods or cycles, and cosmic influences.

Taking Angot's book as a whole, there is a deliberateness of treatment of each topic which can only be attained either by the making of a bulky volume or the exclusion of many important topics which deserve mention; and in the reviewer's opinion the use of the work as a textbook will be lessened thereby, but its value to the general reader will be increased. The lack of an index is, however, a most serious drawback to the free use of the book as a work of reference, for it requires the knowledge of a specialist to be able to turn at once to minor topics by the aid of the rather full table of contents alone.

Professor Angot's 'Meteorology' is a much more important contribution to French literature than it is to the world's literature of the subject, and it will, undoubtedly, do a great amount of good in supplying French readers with information concerning the present condition of a subject of very rapidly increasing interest. The French meteorological literature of recent years has not been nearly as abundant as that of other countries, and we trust that

this new book may arouse to action other authors and publishers, and especially such as will devote their energies to the presentation of the new meteorology. FRANK WALDO.

The Genesis and Dissolution of the Faculty of Speech. A Clinical and Psychological Study of Aphasia. By JOSEPH COLLINS, M. D., Professor of Diseases of the Mind and Nervous System in the New York Post-graduate Medical School; Neurologist to the New York City Hospital, etc. Awarded the Alvarenga Prize of the College of Physicians of Philadelphia, 1897. New York, The Macmillan Company. 1898. Pp. viii + 432.

This volume, to which was awarded the Alvarenga prize of the College of Physicians of Philadelphia for 1897, is a monograph of importance. There is no more fruitful field of investigation than the various forms of speech disturbance, for the student both of psychology and pathological anatomy. That progress has been slow is due to the fact, as Collins points out, that observation and analysis of speech defect has been inaccurate and post-mortem examinations incomplete. If not offering very much that is new the book before us has the merit of calling attention to our deficiencies and of urging greater care in the future. The author shows from beginning to end an admirable grasp of his subject and a complete acquaintance with the literature, which he has used with skill to produce throughout an eminently readable and stimulating book.

The monograph opens with a chapter on 'Disorders of intellectual expression, known as aphasia.' This is largely a discussion and criticism of terms, the outcome of which is a general classification of aphasia as follows:

1. True aphasia—aphasia of apperception. Due to lesion of any constituent of the speech region, the zone of language.

2. Sensory aphasia. Due to lesion of the central and peripheral pathways leading to the zone of language.

3. Motor aphasia. Due to lesion of the motor pathways, over which motor impulses travel in passing to the peripheral speech musculature.

4. Compound aphasia. Any combination of two or more of these.

Such a classification the author regards as sufficient for all practical purposes, but as a concession to established usage he makes certain sub-divisions in order to avoid possible confusion of nomenclature. For example, he retains the word 'motor' as applied to aphasia produced by lesion of Broca's convolution 'solely because such usage has been consecrated by time,' and not because he believes this center to be in reality entirely motor.

Following this chapter is a valuable historical sketch comprised in twenty-three pages, with a good bibliography. Charcot's autonomous speech centers are sharply criticised, both here and later in the book, and Dejerine's services to the subject receive the warmest appreciation, particularly because of their general opposition to Charcot's views.

Under the heading of 'An analysis of the genesis and function of speech,' Collins analyses, from the point of view of physiological psychology, the various elements which ultimately result in the development of the faculty of speech. It is clearly too large a subject for so cursory a handling, and on the whole is less satisfactory than the discussions which are concerned solely with the physical side of the process.

Chapter IV. concerns itself with remarks on the anatomy of the brain, the zone of language, and the evidence regarding a special graphic motor center. It is largely anatomical and presents with clearness the facts we should know relative to the structure of the brain in general, and particularly of those parts to which are attributed special functions in regard to speech. Flechsig's recently expressed views as to the zones of projection and the zones of association are narrated in considerable detail, because of their more or less direct bearing upon the conception of aphasia which the author has elaborated. Collins is definite in his opinion that the zone of language, made up mainly of Broca's convolution, the posterior portion of the first temporal convolution, and the angular gyrus, does not send fibers directly into the motor projection tract. The Rolandic cortex must first be called upon before an idea can be expressed as speech. He is equally confident that we now have sufficient evidence to overthrow com-

pletely Charcot's conception of four more or less independent centers and particularly of a so-called graphic center, and that we may confidently maintain that the zone of language is, as it were, a unit in its action, no part of which may be seriously injured, without in a measure impairing the entire mechanism of speech. These claims are supported by much skilful analysis of reported cases, and a careful reading leaves us with the conviction of the reasonableness of Collins' views.

The greater part of the remainder of the book is taken up with a more detailed consideration of the varieties of speech disturbance, frequently and pleasantly interrupted by the narration either of personal cases or of cases reported by others. In the discussion of motor aphasia much stress is laid upon a distinction too often overlooked, namely, that between *cortical* and *sub-cortical* motor aphasia. In the failure to recognize this distinction—and the same applies to sensory aphasia—Collins sees one of the greatest impediments to progress in our knowledge; and, conversely, the greatest possible hope for more accurate knowledge in the future must lie in the careful microscopic study of the brains of aphasic individuals, particularly when the lesion lies beneath the cortex. The details of differential diagnosis do not concern the present review, but these chapters are to be cordially recommended to those desiring something beyond a vague conception of the real problems of the future.

The diagnosis, etiology, morbid anatomy, treatment and, finally, the medico-legal aspects of aphasia are discussed in a somewhat less complete form, as the scope of the book amply justifies. Collins disagrees with certain other writers as regards the responsibility of the aphasic. His contention here is that in so far as internal speech is unaffected, or put anatomically, if the cortical areas for stored memories are intact, a person must be regarded as responsible, other things being equal. If, on the contrary, such areas are involved, *e. g.*, the area for motor word memories, the person's testimentary capacity should always be called in question. Hence, again, the extreme importance of determining whether the lesion leading to the speech defect be actually in the zone

of language or in that part of the mechanism which simply subserves the emission of words—sub-cortical.

In general the monograph must be regarded as a valuable contribution to American neurological literature. The subject-matter is presented in a scholarly way, and with a directness and certainty of his position which is characteristic of the author. It is to be regretted that Bastian's recent work should have been published too late to be fully included in Collins's critical analysis. On the whole the author's conception and treatment of his subject seem to us sound and representative of the best type of scientific discussion. He gives us many new observations, worked out with the detail particularly after death, which he so urgently recommends, but this, no doubt, is due to lack of opportunity.

The style is for the most part clear. There is, however, a constant tendency to use unnecessarily pedantic words, for which we can find no excuse. In writing on scientific subjects simplicity of diction is surely a first requisite and this Collins lacks. The following words and expressions are correct, it may be, but certainly not well chosen: 'Ancientness,' 'superambient cortex,' 'speechfulness,' 'cotton raguard,' 'perishment,' 'disablement.' This is, however, a minor criticism in an otherwise excellent piece of work.

The book is admirably printed on rather necessarily heavy paper and the proof reading is almost faultless. An index adds materially to its usefulness and convenience.

E. W. T

Codex Borbonicus. Manuscrit Méxicain de la Bibliothèque Du Palais Bourbon, Livre de coutumes et Rituel figuré. Publié en fac-simile avec une commentaire explicatif par M. E.-T. Hamy. Paris, 1889. ERNEST LEROUX, Editeur. Text pp. 1-24, introduction and 4 chapters. Plates folded screen fashion. No's. 2-38 in colors.

This ancient Mexican book, formerly known as the Codex Législatif, is now published for the first time, in exact fac-simile, color, size and form. The original is on maguey paper, and

the drawing is the work of an artist, displaying an accuracy not seen in any of the other Mexican codices. It has been hidden from the world in the recesses of the library of the Chamber of Deputies, Paris. The writer had the privilege of carefully examining it in 1895, in company with the Duke of Loubat, through whose generosity its publication has been made possible. The bright colors with which it was painted are still well preserved, and the whole codex is in excellent condition. The first two pages and probably the last two are missing, undoubtedly having been destroyed, or abstracted shortly subsequent to the conquest. The division and mutilation of the Mexican codices is a well-known fact. This book, folded screen fashion, is painted upon but one side, unlike the majority of the Pre-Columbian codices. The pages bear texts written in poor Spanish, partly explanatory of their meaning. The first 18 pages contain the *Tonalamatl*, the divinatory or astrological calendar of the Aztecs. The contents of the missing first two pages can be supplied by a study of the other ritualistic calendars, of the Codices Vaticanus 3773, Vaticanus 3738, Borgianus, Bologna and the Boturini-Aubin-Goupil *Tonalamatl*. This subject has been exhaustively treated by Dr. Ed. Seler. The *Tonalamatl* of the Codex Borbonicus is far more complete than any other yet published, and helps to clear up some of their obscure points. Pages 19 to 38 contain astronomical, religious and historical material of great interest, and somewhat resemble the paintings found in the Codex Telleriano Remensis of the National Library, Paris, and its counterpart Codex Vaticanus 3738. Pages 37 to 38 are instructive from the historical standpoint. Page 37 represents the two prophets who foretold to Montezuma the coming of the Spaniards to subdue the country. The dates: 1, Tochtli; 2, Acatl; 3, Tecpatl, 1506-7-8, accompany these figures, and suggest that the priests had heard of the appearance of the ships of Diaz de Solis and Pinzon off the coast of Yucatan in 1506, notice of which was undoubtedly carried to most parts of the culture area.

When all the old Mexican codices are reproduced separately then the study will be much simplified, and it is gratifying to note the progress now being made in this direction, at

the present time several unpublished codices being in process of publication.

M. H. SAVILLE.

Pflanzengeographie auf Physiologischer Grundlage. Von DR. A. F. W. SCHIMPER. Mit 502 Tafeln und Abbildungen in autotypie, 5 Tafeln in Lichtdruck, und 4 geographischen Karten. Jena, Gustav Fischer. 1898. 8vo. Pp. vi + 876.

The appearance of this text marks a distinctive period in the development of phytogeography. The treatment is primarily ecological, but the floristic is presented so fully and woven in so logically that the arrangement is strictly phytogeographical in the best sense. Such a coordinate presentation of the subject-matter is novel. The standard texts, especially such classic ones as Humboldt's, De Candolle's and Grisebach's, have been almost wholly floristic, while Warming's recent *Lehrbuch der Oekologischen Pflanzengeographie* is, of course, purely ecological. Sketches of particular floras have, likewise, been floristic in character, to the practical exclusion of the ecological standpoint. Naturally, this does not mean that the author is the first to perceive the essential relation between floristic and ecology, a relation practically of cause and effect. The recognition of this fact is as old as Humboldt's first work. It does indicate, however, the advance made in systematizing and in making more thorough the methods of investigating the floral covering. The appearance of the present excellent text evidences the author's realization of his opportunity. The skillful manner in which the matter is handled bespeaks no small mastery of the subject. The volume contains a number of original and suggestive ideas, only a few of which can be mentioned here.

The work consists of three parts, the first treating of the factors in ecology, the second of formations and plant societies, the third of the zones and regions of the floral covering of the globe. The ecological factors considered in the first part are water, temperature, light, soil, atmosphere and animals. The treatment of each subject is as exhaustive as can be expected in a general text, especially in consideration of the enormous mass of detail available. In thorough-

ness and in manner of presentation of this portion, the book is probably without an equal. With respect to water content as a factor, Schimper's divisions agree with those of Warming, except that he uses the term *tropophyte* for *mesophyte* to apply to all plants not *hydrophytes* or *xerophytes*. The same criticism applies here that has been made elsewhere against Warming's *mesophytes*. The term is a convenient one, but it designates an ill-defined group and is almost impossible in application. The analysis of the conditions producing *xerophytes* is critical; such conditions are here grouped with reference to decrease of absorption and increase of transpiration. Under the former are ranged small water content, abundance of salts or humic acid in the soil, low soil temperature; under the latter, low degrees of humidity of the air, high temperature, low atmospheric pressure, intense illumination. Corresponding to these characteristics, *xerophytic* habitats are: (1) deserts and steppes, with a dry substratum and a dry atmosphere, often, also, with excessive heat and intense sunlight; (2) rocks and tree trunks, with low water content due to rapid drying; (3) sandhills, rubble, talus, with extremely porous soil; (4) seashore, solfatara, with abundant salts in solution in the soil; (5) moors, with humic acid in the soil; (6) polar areas, either in glaciated mountain ranges or in arctic latitudes, with extremely low ground temperature; (7) alpine mountains with rarefaction of the atmosphere and strong insolation. The consideration of *hydrophytes* and *tropophytes* is naturally much more restricted. Schimper regards water plants proper as descended from primitive unstable amphibious forms—a conclusion rather too theoretical to be generally accepted. He closes this section with a condensed statement of the relation of water to reproduction and to dissemination.

In the consideration of temperature the author expressly states that he regards this factor of primary importance. He places its treatment after that of water solely because the modifications due to the latter are more easily investigated and determined. The consideration of temperature extremes is followed by that of optimum temperatures, in which the work of Sachs and Haberlandt is largely drawn upon.

Acclimatization is touched upon only briefly, for the most part with reference to Mayr's contributions. For the general reader one or two re-statements are interesting: that no portion of the earth's surface is too cold for plant life, as with few exceptions, no portion is too hot; that it is nowhere too dark, nowhere too bright, for plant life. There is opportunity to take exception to the sweeping nature of these statements, but they are hardly intended to be taken as absolute. Under atmosphere is considered atmospheric pressure, air content of water and winds. The relatively much greater effect of the wind upon woody formations is pointed out as also the influence of the wind upon transpiration. No mention is made, however, of the action of the wind in dune regions, sandhill and deserts, where it plays a primary rôle in the determination of the floral covering. The importance of winds in pollination and dissemination is treated briefly.

The chapter upon soil as an ecological factor is very skillfully summarized. Though brief, it is so comprehensive that recapitulation is impossible here; one can only reaffirm its excellence. The influence of animals upon vegetation has not been given as much attention as would be expected. Too little use has been made of the vast accumulation of data in this field. In many instances the ecological significance has not been fully wrought out. Moreover, a large number of important biological factors in ecology, arising from the interrelations of plants to plants, and of plants to the physical conditions, such as vegetation pressure, zonation, layering, etc., have been entirely neglected.

It is impossible to accept the author's grouping of formations into climatic and edaphic in the absolute way he seems to intend it. Forests, prairies and deserts are not purely, nor always primarily, determined by climatic factors. The so-called edaphic formations, determined though they are by soil characteristic, are often not formations, but zones or patches. They are but rarely coordinate with the author's climatic formations. The conception of the facies, moreover, differs from that of Drude, which has been accepted in this country. The division of the floral covering into forests,

prairies or steppes and deserts is, of course, primary and affords an altogether satisfactory basis for the arrangement of the formations. The statement that the constitution of the floral covering is determined by the three factors, temperature, hydrometeors and soil, is axiomatic; one is inclined, however, to give only partial assent to the conclusion that temperature determines the flora, hydrometeors the vegetation, and soil composition the formation. The analysis of the determining factors of forest, prairie and desert vegetation is excellent. Moderate frequency of precipitation is of first importance for forest vegetation. A rainy growing period is less favorable, the primary requisite being considerable water content in the soil, especially at some depth. The time of year in which the water supply is replenished is unimportant. The latter may occur throughout the year or only periodically. In the last case the rainy season may coincide for the most part, or entirely, with the growing period, as in the tropics and in the interior of Argentina, or with a period of relative rest, as in extra-tropical regions with wet winters, Mediterranean countries, Chili, California, south and southwest Australia. Forests are limited only by such degrees of dryness as prohibit all other vegetation, with the exception of fungi and algæ. The polar limit of forested areas is determined by dry winds during the season of frosts. Summarizing, a climate favorable to forestation presents the following conditions: warm growing period, constantly moist substratum, moist, quiet atmosphere, particularly in winter. It is unimportant whether the water content of the soil is supplied from meteoric or telluric sources, whether the precipitation is frequent or rare, coincident with the growing period or the period of rest. A climate with dry winters is unfavorable to forests in the highest degree, since the trees are unable to recover from the transpiration loss of the winter.

For prairies and steppes a moist substratum is unimportant, but a moist upper surface is essential. The most favorable conditions for grass vegetation are frequent, if only slight, precipitation during the growing period and concomitant moderate warmth. Prairies are affected little by the moisture of the substratum,

except in the case of extreme capillarity of the surface, by the dryness of the air, especially during the period of rest, and by winds. Dryness in the maximum of the growing period, spring and early summer, is inimical, in a high degree, to grass vegetation. Axiomatically, in a climate favorable to forestation, forests predominate; in one favorable to grasses, prairies and steppes are the rule. In transition regions predominance is determined by adaptation to edaphic factors. Extreme departures from the mean favorable to forest or to prairie vegetation produce deserts.

It is impossible even to touch upon the third part of the volume, which constitutes by far the largest portion. It deals with the zones and regions of the vegetative covering of the earth. The latter is treated in the most exhaustive manner since Grisebach under the captions: tropical zone, temperate zone, arctic zone, montane regions and hydrophytic formations. Each zone is considered in a very logical manner with reference to the three main manifestations of the vegetation, forest, prairie and desert. The high value of the text is greatly enhanced by the large number of fine illustrations. It seems impossible to commend too highly this marked feature of the book. It may be regarded as significant of the time when phytogeographical results will be embodied, for the most part, in graphic fashion, in photographs, abundance-frequency indices and charts, and formational lists and contrasts.

FREDERIC E. CLEMENTS.

THE UNIVERSITY OF NEBRASKA.

Victor von Richter's Organic Chemistry. Edited by Professor R. ANSCHÜTZ, University of Bonn. Authorized Translation by EDGAR F. SMITH, Professor of Chemistry, University of Pennsylvania. Third American from the eighth German edition. Vol. I., Chemistry of the Aliphatic Series. Philadelphia, P. Blakiston's Sons & Co. 1899. Pp. 625. Price, \$3.

Anschütz, in editing v. Richter's 'Organic Chemistry,' has raised it from the rank of a good descriptive manual to a place in the front rank of books on this subject. He has had the aid of Emil Fischer in the supervision of the chapters

on the carbohydrates and on uric acid; of v. Baeyer, Claisen, Waitz and others on the work in their respective fields.

The introduction occupies 77 pages, and among other subjects includes condensed presentations of the aims of physical chemistry and stereochemistry, of the work based on the optical and magnetic properties of carbon compounds, and of that based on measurements of conductivity. The book is written tersely and clearly. The nomenclature in common use is retained, but that recommended by the Geneva Conference is also given. The literature and historical references are abundant.

Professor Smith's translation is very good. A slip is on page 122, where wine is said to be obtained from 'St. John's berries'; a term not found in the Century Dictionary. The German word 'Johannisbeeren' means currants. The volume before us contains the results of the latest work on the subject, and, as the second (and last) volume on the aromatic series is promised by the publishers during the present year, the student purchasing this excellent book may feel confident that he has the last word on the subject up to the date of publication.

E. RENOUF.

Physical Chemistry for Beginners. By DR. CH. VAN DEVENTER. With an Introduction by Professor J. H. VAN'T HOFF. Authorized American edition from the German edition. Translated by BERTHRAM B. BOLTWOOD, PH.D., Instructor in Physical Chemistry in the Sheffield Scientific School of Yale University. First edition, first thousand. New York, John Wiley & Sons; London, Chapman & Hall, Limited. 1899. Pp. 154.

In the preface it is stated that "in the book at hand the author has endeavored to collect the most important results of physical chemistry in such a manner that this important branch of modern chemistry may be accessible to those who have not made an exhaustive study of physics and mathematics. The requirements of students of medicine and pharmacy, as well as of elementary chemistry, have been especially considered in the preparation of this work."

Chapters are devoted to the fundamental

laws of composition, the properties of gases thermochemistry, solutions, phenomena of light and the periodic system. It would seem that a chapter on electrochemistry would add to the value of the book.

The work has been used by Van't Hoff in connection with his lectures on chemistry to students in Amsterdam, and is spoken of as having furnished him welcome assistance.

The work of translation has been done with care by Dr. Boltwood, his purpose being, in part, to place in the hands of his own student a book which shall contain a clear and concise statement of the fundamental facts of physical chemistry.

HARRY C. JONES.

BOOKS RECEIVED.

Das Tierreich. 7 Lieferung, *Demodicidae* und *Sarcoptidae*. G. CANESTRUM and P. KRAMER. Pp. xv + 193. M. 9.20. 8 Lieferung, *Scorpiones* und *Pedipalpi*. KARL KRAEPELIN. Pp. xviii + 265 M. 12.60. Berlin, R. Friedländer und Sohn. 1899

Steinbruchindustrie und Steinbruchgeologie. O. HERRMANN. Berlin, Borntraeger. 1899. Pp. xvi + 428. M. 10.

Essai critique sur l'hypothèse des atomes dans la science contemporaine. ARTHUR HANNEQUEN. Paris, Alcan. 1899. Second Edition. Pp. 457.

The Newer Remedies. VIRGIL COBLENTZ. Philadelphia, P. Blakiston's Sons & Co. 1899. Third Edition. Pp. vi + 147. \$1.00.

The Psychology of Reasoning. ALFRED BINET. Translated from the second French edition by ADAM GOWANS WHITE. Chicago, The Open Court Publishing Co. 1899. Pp. 191.

SCIENTIFIC JOURNALS AND ARTICLES.

THE first article in the *American Naturalist* for May is by H. S. Jennings, and is a continuation of 'Studies on Reactions to Stimuli in Unicellular Organisms.' The present part, III., treats of 'Reactions to Localized Stimuli in Spirostomum and Stentor,' the writer reaching the conclusion that the organisms react as individuals and not as substances. But while it will not do to think of their reactions as those of chemical substances, neither will it do to attribute to unicellular organisms the psychological powers of higher animals. Under the title of 'Vacation Notes, II., The Northern Pacific

Coast,' Douglas H. Campbell touches on the botany of that region. W. D. Matthew considers the question: 'Is the White River Tertiary an *Æolian* Formation,' deciding it in the affirmative. F. H. Herrick describes several cases of 'Ovum in Ovo,' and after classifying the various methods in which such abnormalities occur presents theories which account for them. The concluding paper by T. D. A. Cockerell is 'On the Habits and Structure of the Coccid Genus *Margarodes*.' Among the editorials is one on 'The Gypsy Moth and Economic Entomology,' in which the ground is taken that it is not worth while to continue the present extravagant policy. The number is unusually full of brief and good reviews of recent scientific literature.

THE March number of the *Bulletin of the American Mathematical Society* contains: 'On Singular Points of Linear Differential Equations with Real Coefficients,' by Professor Maxime Bôcher; 'The Hessian of the Cubic Surface,' by Dr. J. I. Hutchinson; 'On the Simple Isomorphisms of a Hamiltonian Group to Itself,' by Dr. G. A. Miller; 'Galois's Collected Works,' by Professor James Pierpont; 'Three Memoirs on Geometry,' by Professor Edgar Odell Lovett; 'Stahl's Abelian Functions,' by Dr. Virgil Snyder; 'Calculus of Finite Differences,' by Dr. D. A. Murray; 'Notes' and 'New Publications.' The April number of the *Bulletin* contains an account of the February meeting of the American Mathematical Society, by Professor F. N. Cole; 'Determinants of Quaternions,' by Professor James Mills Pierce; 'The Largest Linear Homogeneous Group with an Invariant Pfaffian,' by Dr. L. E. Dickson; 'Asymptotic Lines on Ruled Surfaces having Two Rectilinear Directrices,' by Dr. Virgil Snyder; 'Willson's Graphics,' by Dr. J. B. Chittenden; 'Pascal's Repertorium of Higher Mathematics,' 'D'Ocagne's Descriptive and Infinitesimal Geometry,' by Professor Edgar Odell Lovett; 'Sophus Lie,' translation of Professor Gaston Darboux's notice; 'Notes' and 'New Publications.' The May number of the *Bulletin* contains an account of the April meeting of the Chicago Section of the Society, by Professor Thomas F. Holgate; 'An Elementary Proof that Bessel's Functions of the Zeroth Order have an Infinite Number of Real Roots,'

by Professor Maxime Bôcher; 'A Generalization of Appell's Factorial Functions,' by Dr. E. J. Wilczynski; 'On the Arithmetization of Mathematics,' by Professor James Pierpont; 'Two Books on the Tides,' by Professor Ernest W. Brown; 'Notes' and 'New Publications.'

THE *Annals of Mathematics* will henceforward be published quarterly, beginning with the number issued on October 1st, by the department of mathematics of Harvard University. Professor Ormond Stone, of the University of Virginia, who founded and for many years supported the journal, has consented to act as a member of the board of editors in coöperation with Professor H. S. White, of Northwestern University, and Professors Byerly, Osgood and Bôcher, of Harvard University. The editors state that their object is to conduct the journal so that it may appeal not merely to the highly trained specialist, but to the general mathematical public of America from students of mathematics in the graduate schools of our universities upward. Short research articles will be welcomed, but highly technical articles will be avoided. Articles containing little or no absolutely new matter, but giving a clear presentation of some important but not readily accessible field of mathematics, or a more thorough presentation of some subject which is generally treated in an unsatisfactory manner, are especially desired.

SOCIETIES AND ACADEMIES.

CHEMICAL SOCIETY OF WASHINGTON.

THE regular meeting was held on April 13, 1899.

The first paper of the evening was read by Mr. J. K. Haywood, and was entitled 'Some Boiling-Point Curves.' The results obtained have led to the following conclusions:

I. All mixtures of the following pairs of liquids boil at temperatures between the boiling points of the constituents: alcohol-water, alcohol-ether, chloroform-carbon tetra-chloride, acetone-water and acetone-ether.

II. A solution containing 17.5 % alcohol in carbon tetra-chloride distills without change at 65.5° approximately, under a pressure of 768.4 mm. of mercury.

III. A solution containing 12.5 % methyl al-

cohol in chloroform distills without change at 54° approximately, under a pressure of 770.2 mm. of mercury.

IV. A solution containing 12-13 % methyl alcohol in acetone distills without change at 55.9°, under a pressure of 764.8 mm. of mercury. The boiling point of this mixture is about 0.8° below that of the constituent which is present in greatest amount.

V. A solution containing 15-20 % of carbon tetra-chloride in acetone distills without change at a temperature but 0.05° below that of the pure acetone, and all mixtures containing more than 40 % acetone boil within one degree of the boiling point.

VI. The close proximity of the boiling points of the constituents appears to be a favorable condition for the existence of a maximum or minimum point on the boiling-point curve.

VII. In general one constituent remaining the same, mixtures with substances of similar chemical constitution yield similar boiling-point curves.

The second paper was read by Dr. F. K. Cameron, and was entitled 'Boiling Points of Mixtures.'

Dr. H. C. Bolton read an interesting paper on 'The Development of Pneumatic Chemistry,' which was profusely illustrated with lantern slides.

WILLIAM H. KRUG,
Secretary.

GEOLOGICAL CONFERENCE AND STUDENTS' CLUB OF HARVARD UNIVERSITY.

Students' Geological Club, April 11, 1899.—Mr. L. La. Forge reviewed Gregory's 'Plan of the Earth,' indicating several questionable steps in that writer's recent exposition of the subject. Mr. A. W. G. Wilson described a unique lake in Ontario, which is known as Lake-on-the-Mountain.

Geological Conference, April 23, 1899.—Mr. R. E. Burke communicated 'The Discovery of Fossils in the Roxbury Conglomerate,' and will publish on it at an early date.

Under the title 'Mineral Veins of the Mystic Quarries, Somerville,' Mr. R. B. Earle reported the results of his studies in that field. The veins, which are almost entirely limited to

a dike and a sill, are composed chiefly of calcite, but include small amounts of quartz, pyrite and prehnite. The speaker divided the fissures which these veins fill into five classes according to their origin, which he believed to have been by contraction of the molten magma, by earthquakes, by torsion, by faulting or by decomposition. The growth and enlargement of the fissures, when once formed, was held to be mainly due to the expansive force of the vein filling substance.

Mr. G. C. Curtis exhibited a topographical model, which he has constructed, of an area located in the eastern foothills of the Cascade Range, near the great bend of the Columbia River, in Kittitas County, Washington.

J. M. BOUTWELL,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

TELEPATHY ONCE MORE.

TO THE EDITOR OF SCIENCE: Why Professor Titchener should have taken an essay which now admits to have completely failed even to make probable its point, as an example of the 'brilliant work' which 'scientific psychology can do in the way of destroying the telepathic superstition, may be left to be fathomed by readers with more understanding of the ways of 'Science' than I possess.

Meanwhile, as one interested in mere accuracy, I must protest against two impressions which Professor Titchener, in your number of May 10th, seeks to leave upon the reader's mind.

The first is that whispering was first considered by Professor Lehmann. It has been elaborately discussed in the S. P. R. Proceeding over and over again. Sidgwick's 6-page discussion of it in the report of his own experiments is the basis of comparison used by Lehmann in his ampler but abortive investigation.

The second of Professor Titchener's implications is that it was Lehmann who introduced number-habits, and even forced the admission of them on the recalcitrant Sidgwick. Lehmann makes no mention of number-habits. Sidgwick himself introduces them to account, not for the thought transference results, but for the many errors common to the guesses of his Subjects and

Lehmann's; the two perhaps had the same number-habit. Does Professor Titchener seriously think that a number-habit in a guesser can account for the amount of coincidence between the numbers which he guesses and those upon counters drawn at random out of a bag?

Even in anti-telepathic Science accuracy of representation is required, and I am pleading not for telepathy, but only for accuracy.

WILLIAM JAMES.

ON THE WEHNELT CURRENT BREAKER.

TO THE EDITOR OF SCIENCE: The following facts, noticed while experimenting with the Wehnelt electrolytic current breaker, may be not without interest:

In order to test if the action of the breaker could be due to a spheroidal state, produced by the high temperature of the positive electrode, some means for measuring the temperature of this electrode had to be obtained. For this purpose I used electrodes of fusible metals melting at different temperatures, the temperature of the electrode being necessarily less than that at which the alloy melts, if the latter remain unfused. In this way one can at least obtain the superior limit for the temperature of the electrode. Starting with a fusible alloy which melted at about 78° C., the electrode melted as soon as the circuit was closed. The next metal used melted at 96° C., and was fused an appreciable, though very short, time after the current was established. Finally, using an anode made of a metal which melted at 168° C., no indication of fusion of the electrode could be detected, even after the breaker had run for ten minutes at a time. This seems to show that the temperature of the electrode was far below 200°, the temperature necessary, at atmospheric pressure, for the production of the spheroidal state.

The influence of self-induction on the action of the breaker was also studied, to some extent. Diminution of the self-induction in circuit diminishes the period of the action, as is shown by the heightened pitch of the sound produced. But absence of all self-induction prevents wholly the working of the breaker. The cell was used in a circuit composed of a storage battery, non-

inductive electrolytic resistances and wires wound non-inductively. With this arrangement no interruption of the current could be produced, though the electromotive force was raised to thirty volts and the current to eighteen amperes. As soon, however, as a coil with self-induction was put in the circuit the action of the breaker recommenced. Induction in the circuit is essential to the action of this form of interrupter.

HOWARD McCLENAHAN.

PHYSICAL DEPARTMENT, PRINCETON UNIVERSITY.

THERMODYNAMIC ACTION OF 'STEAM-GAS.'

ONE of the most valuable papers recently published in the fields of applied science is that which has just been reprinted from the *Revue de Mécanique* of the last year, the work of Professor Sinigaglia, a well-known author in that field.*

This is the latest and, in many respects, the most complete discussion of a supremely important subject; one to which the minds of men of science and engineers the world over are now again turning after a period of many years, during which the thermodynamic promise of gain in efficiency in the steam-engine through the conversion of a vapor into a gas by this process of superheating had been almost universally believed to be more than counterbalanced by the very serious difficulties met in the earlier days in the attempt to profit by it. Changes have taken place during the last generation which are now thought by many authorities to have largely reduced the obstructions formerly seemingly fatal to a great thermodynamic advance.

In the practical thermodynamic operation of the steam-engine, as M. Bertrand has remarked, there is no such thing as 'saturated vapor,' as that term is customarily employed by the thermodynamists. The working fluid is always, in fact, a mixture of vapor and its liquid, in a

*Application de la Surchauffe aux Machines à Vapeur par M. François Sinigaglia, Professeur agrégé des Ingénieurs de Naples; Ingénieur-Directeur de l'Association des Propriétaires d'Appareils à Vapeur dans les Province napolitaines. Extrait de la *Revue de Mécanique* (1897-98); Paris, V'Ve Ch. Dunod, Éditeur, 1898.

state of instability as to quality. The investigations of the '*théorie générique*' made by Rankine, Clausius, Zeuner and others resulted in establishment of no rational expressions for the actual heat-exchanges of the real, as distinguished from the ideal, engine, and Hirn's '*théorie expérimentale*,' as developed by that great investigator and his disciples, is still the only resort of the student of the curious extra-thermodynamic processes accompanying the thermodynamic operation of the engine.

Superheating has come to be looked upon, not as method of giving superior thermodynamic action, but as simply a provision for reducing internal wastes due to heat-exchanges between the steam and the metal surrounding it. Its effectiveness was recognized as early as Trevethick's time (1828 or earlier) and became well understood about the middle of the century; since which time numerous inventions have been made, looking to its utilization, few giving any promise of success. The Alsatian school has revealed very completely the method and the effect of its adoption, and it has come to be well understood that its province is simply to reduce that form of waste known as 'initial condensation' or 'cylinder condensation.' Its successful use would effect the suppression of those losses in such manner, in the words of Dwelshauvers-Dery, as to give maximum efficiency by securing the exhaust of the steam from the engine in the dry and saturated condition. This is, in his opinion, the practical criterion of most perfect action. The actual gain has been found by Hirn to be, in several cases studied by him experimentally, from 20 to nearly 50 per cent., with a superheat amounting to from 210°C. to 245°C. The nearest approximation yet reported to the ideal, purely thermodynamic, case has been effected by this means—particularly, of late, by Schmidt.

The failures of the past have been due to difficulties in securing an apparatus which cannot be rapidly injured by excess of heat in presence of superheated vapor of water, and a system of lubrication of the cylinder and piston capable of working satisfactorily at the temperatures attained in effective superheating. The latter obstacle is now overcome, largely, by the use of the high-test mineral oils; the former

remains a serious obstruction. The increased steam-pressures of our day also reduce both need and the availability of increasing superheat.

The results of successful superheating exhibit themselves both at the engine and at the boiler, and, as with multiple-cylinder engines, the gain at the boiler in economical employment of superheat is greater than that at the engine through a more perfect thermodynamic action; for the reduction of the demand for steam at the engine results in an increased economy in the production of such steam through the larger proportion of heating surface to weight of steam produced. Thus a gain of 20 per cent. at the boiler may be accompanied by a gain of 22 per cent. or more in fuel as measured at the boiler. The desirable amount of superheat is that which will prevent the condensation of the vapor entering the steam-cylinder and insure its rejection as saturated vapor at exhaust.

The apparatus employed by various inventors and investigators in this field, from 1850 to the present time is described at considerable length by M. Sinigaglia, and the results of experiment are recited. In many instances, recently, particularly, it is reported that no serious inconveniences were met with in the application of the superheat system; in other cases much trouble and sometimes serious accidents resulted, due to the 'burning' of the apparatus and its yielding thus weakened, to the pressure. Messrs. Ludwig and Weber obtained, in an extensive series of experiments in Alsace, some very encouraging figures. An average gain of 7.5 per cent. net, was secured by moderate superheat (44°C.). Messrs. Walther-Meunier, and Ludwig, later reported a gain of 13 to 15 per cent. from a superheat of somewhat greater amount. Schwoer obtained a gain in efficiency of 15 to 18 per cent. by superheating 68°C. Hirsch reported similar figures from an equal amount of gasification in a marine apparatus. Schroeter obtained gains of 10 per cent. and more in a very elaborate and detailed investigation, in which the superheat amounted to 60°C. The most remarkable results reported are those of Schmidt, who, by adopting an enormous portion of superheating to heating surface (six to one), secured a superheat of 190°C., and at another time, with:

comparatively small apparatus, secured the highest record yet established. With another engine a gain in weight of steam supplied the engine amounting to nearly 40 per cent. was effected, and in weight of fuel 28 per cent.; the difference being due, obviously, to the fact that each unit-weight of steam carried an abnormal quantity of stored heat.

Professor Sinigaglia concludes:

1. Superheating vapor is irrefutably proved to be the most effective system of reduction of internal wastes of heat in the steam-engine.

2. The higher the degree of superheating attainable, the nearer does the thermodynamic result approximate that indicated by pure theory and by the formulas of thermodynamics.

3. From the industrial point of view, it is necessary to note the gain, not at the engine, but in fuel demanded at the boiler, and the apparatus of vaporization and of gasification must be efficient and durable.

4. The final test is in the study of the financial aspect of the operation.

"Mais, aujourd'hui, les installations nombreuses de l'Alsace et de l'Allemagne ont donné des résultats si remarquables qu'on finira par vaincre les dernières difficultés qui s'opposent à une application générale de la surchauffe aux machines à vapeur. Ce sera le meilleur hommage rendu à Hirn et à son école."

R. H. THURSTON.

THE REMOVAL OF DR. WORTMAN TO THE CARNEGIE MUSEUM.

DR. J. L. WORTMAN, of the American Museum of Natural History, has been called to take charge of the new collections of Vertebrate fossils in the Carnegie Museum at Pittsburgh, and has resigned his position in the American Museum in order to enter upon his new duties. The finest portions of the Cope collection of Fossil Mammals were made by Dr. Wortman previous to his connection with the Army Medical Museum in Washington. Since 1890 he has had charge of most of the parties sent out from the American Museum for Fossil Mammals and Reptiles and has conducted these explorations with extraordinary success. A very large part, therefore, of the collections in the Department

of Vertebrate Paleontology are due to the energy and intelligence of Dr. Wortman and his assistants in the field. His field work has been carried on almost exclusively during the summer months, and he has been occupied during the winters in the preparation of a series of bulletins based chiefly upon the field collections, many of which have attracted wide attention. Notable among these are the papers upon the Skeleton of *Patriofelis*, the Anatomy of *Agriochærus*, the revision of all the early species of horses, and a geological paper upon the Stratigraphy of the White River Beds. The most important of his original contributions in the series is, however, that upon the 'Origin of the Sloths,' based chiefly upon the fortunate discovery of the foot of *Psittacotherium* in the Torrejon beds of New Mexico. Dr. Wortman's latest paper, now in press, is upon the Ancestry of the Dogs, in which he successfully demonstrates the direct phylogenetic relationship between the Canidæ and of certain dog-like Creodonts.

Dr. Wortman's services to the Museum are greatly appreciated and his resignation has been accepted with much regret. He carries with him the best wishes of his friends for his success in his new undertaking.

H. F. O.

SCIENTIFIC NOTES AND NEWS.

PROFESSOR F. L. O. WADSWORTH has been appointed by the managers of the Western Pennsylvania University, Director of the Allegheny Observatory, succeeding in the position Professors Keeler and Langley. Professor Wadsworth has been connected with Yerkes Observatory since its opening and was previously at the Astrophysical Observatory of the Smithsonian Institution.

UNDER authority of the Secretary of the Treasury, the Superintendent of the Coast and Geodetic Survey has effected a reorganization in that Bureau in such a way as to relieve the head of the Bureau of a certain amount of the routine work and to insure also a more direct supervision of the field work. The following officers have been appointed: Assistant Superintendent, Mr. O. H. Tittman; Assistant in charge of the Office, Mr. Andrew Braid; In-

spector of Field Work in Hydrography and Topography, Mr. H. G. Ogden; Inspector of Field Work in Geodesy, Mr. John F. Hayford; Inspector of Field Work in Terrestrial Magnetism, Dr. L. A. Bauer.

M. PRILLEUX, known for his researches on the parasitic diseases of plants, has been elected a member of the Section of Botany of the Paris Academy of Sciences. The other candidates nominated by the Section were MM. Bureau, Maxime, Cornu, Renault and Zeiller.

THREE botanists—Professors E. Pfitzer, of Heidelberg; O. Brefeld, of Münster, and E. Warmung, of Copenhagen—have been elected corresponding members of the Berlin Academy of Sciences.

MR. W. H. PREECE, C.B., F.R.S., has accepted the presidency of the 18th Congress of the Sanitary Institute, to be held in Southampton from August 29th to September 2d.

CAMBRIDGE UNIVERSITY has conferred the degree of Doctor in Science, *honoris causa*, on Alexander Kowalevsky, professor of zoology in the Imperial University, St. Petersburg.

THE Prince of Monaco has been elected an honorary member of the Royal Geographical Society of London.

MR. PHILIP THOMAS MAIN, Fellow of St. Johns College, Cambridge, died on May 5th. He lectured on chemistry at St. John's College and did much to promote the study of natural science in the College and in the University. He was also the author of a treatise on astronomy which has passed through several editions.

MR. HENRY WILLIAM JACKSON, a retired surgeon, died at Louth, Lincolnshire, on May 14th, aged 67 years. He founded the Lewisham and Blackheath Scientific Association and was interested in anthropology and astronomy, being a member of the London and Paris Anthropological Societies and a Fellow of the Royal Astronomical Society:

THROUGH some as yet unknown 'accident,' the annual appropriation for the N. Y. State Weather Service were stricken out of the appropriation bill, April 24th last, and it is thus apparently impossible to continue a series of observations,

meteorological and agricultural, that has been carried on without interruption for a generation. In this service, which has its headquarters at Ithaca, in the College of Civil Engineering, nearly 2,500 persons are engaged without cost to the State, including the Director of the College, who is also the Director of the Service. The work of the Bureau has been largely in the interests of the farmers of the State, and the compilation of weekly 'Crop Bulletins,' and the maintenance of a weather-signal station which operates in conjunction with the U. S. Bureau at Washington, has been considered an important service to the whole Commonwealth. The minute appropriations hitherto made, but \$4,500 per annum, by the great State of New York have been entirely inadequate to the opportunities of the Bureau; but the volunteer labor of a corps whose services, if fully compensated, would amount to probably over a quarter of a million of dollars annually have gone far to make up for the defect. Even if re-established, this interruption for a single year will make a break in the files which can never be repaired and which may deprive the State of previously interested, and even enthusiastic, observers by so disheartening them that they will not resume their connection with the system; thus destroying stations having records of a length approximating thirty years.

A MEETING was held on May 20th, at Columbia University, for the purpose of discussing the formation of an American Physical Society, which would hold meetings in New York for the reading and discussion of papers. The meeting was called by the following committee of physicists, representing important American universities: Professor A. G. Webster, Clark University, Worcester; Professor J. S. Ames, Johns Hopkins University, Baltimore; Professor E. L. Nichols, Cornell University, Ithaca; Professor Carl Barus, Brown University, Providence; Professor M. I. Pupin, Columbia University, New York; Professor B. O. Peirce, Harvard University, Cambridge; Professor W. F. Magie, Princeton University, Princeton. It is intended that the new organization shall be for this country what the Physical Society is for England and the Deutsche physikalische Gesellschaft for Germany.

THE Council of the American Chemical Society has authorized the establishment of a section to be known as the Philadelphia Section, with headquarters in Philadelphia, Pa., having a territory with a radius of sixty miles from the Philadelphia City Hall.

THE foundation-stone of the extension of South Kensington Museum, henceforward to be known as the Victoria and Albert Museum, was laid by Queen Victoria on May 17th. Several members of the royal family, foreign diplomatists and members of both Houses of Parliament were among those attending. The Duke of Devonshire, the Home Secretary, and Mr. Akers-Douglas took a prominent part in the proceedings. The Prince of Wales assisted the Queen in the actual laying of the foundation-stone.

A BILL has been introduced into the British Parliament for establishing a Department of Agriculture and other Industries and Technical Instruction in Ireland, and for other purposes connected therewith.

THE United States Civil Service Commission announces that applicants for the position of Inspector of Standards (Office of Standard Weights and Measures), U. S. Coast and Geodetic Survey (Treasury Department), at a salary of \$3,000 per annum, will be permitted to file their applications as late as July 15, 1899, instead of June 1, 1899, as previously announced.

THE Examiners of the U. S. Civil Service Examination for a "Sloyd Teacher" in the Indian Service (Dept. Interior) failed to find candidates, April 11th. The examination will now be held June 6th-7th and the successful applicant will receive \$600 per annum for teaching "basket Sloyd" and carving.

MAYOR VAN WYCK, of New York, has signed the resolution of the Municipal Assembly providing for the issue of \$500,000 bonds to defray the expenses of removing the old reservoir from Bryant Park and building the foundations for the new library. The contract for the work will be let immediately by the Board of Estimate, and the work of tearing down the reservoir will be begun as soon as practicable.

AN anonymous gift of \$25,000 has been made to Long Island College Hospital for the endow-

ment of a fellowship in the department of pathology. The gift is to be known as the Van Cott Fellowship, in honor of Dr. Joshua Van Cott, the director of the laboratory.

THE French Chamber of Deputies has voted an annual appropriation of 92,000 fr. for the publication of the Photographic Atlas of the Stars.

THE French Association for the Advancement of Science will meet at Boulogne on the 14th of September, 1899. As we have already stated, the British Association will meet at the same time at Dover, the meetings of the two Associations having been arranged so as to provide for an exchange of hospitalities.

THE Indian Plague Commission has returned to London and is continuing its meetings in that city.

THE daily papers report that a letter from Andrée has been found on the northeast coast of Iceland and has been forwarded, as addressed, to Gothenburg, Sweden.

AN exhibition is being arranged at The Hague to illustrate what was accomplished by the Netherlands prior to the present century in navigation, discoveries, trade and fisheries. Those in America who possess objects that might be useful for exhibition are requested to communicate with the Honorary Secretary, Mr. G. P. Van Hecking Colenbrander, The Hague.

WE learn from the London *Times* that the two royal gold medals of the Royal Geographical Society have this year been awarded to two Frenchmen, both of them distinguished explorers. Only one French explorer, Francis Garnier, has hitherto figured on the Society's list of honors, and only one other Frenchman, Elisée Reclus. The founder's medal has this year been awarded to Captain Binger, who in the years 1887-89 carried out an extensive series of explorations in the vast area included in the bend of the Niger. During these journeys Captain Binger explored much country previously unknown, took numerous astronomical observations on which to base a map of the region, and in other departments of geography did a great amount of work of high scientific value. The results of Captain Binger's explorations were published in 1892 in

two large volumes, with one large map and several smaller maps and sections and numerous valuable illustrations, which form the chief authority on the geography of the region with which they deal. The patron's medal has been awarded to M. Foureau for his explorations in the Sahara during the last twelve years. In his journey to Insalah in 1890 he travelled over 1,500 miles and fixed the latitudes and longitudes of 35 places; in 1891 he penetrated farther into the Sahara than any other explorer since the Flatters mission, and determined the positions of 41 places; in 1893 he penetrated as far as the Tassili plateau; in 1894-95 he again covered much new ground and made numerous astronomical observations to fix positions, besides making researches in physical geography, geology and botany; in 1896 and in his present journey he contributed still further to geographical knowledge. The whole comprises an amount of continuous scientific work under great difficulties which places M. Foureau in the first rank of African explorers. Few men have done so much to elucidate the topography and the physical geography of the Sahara. The Murchison award has been given to Mr. Albert Armitage for his valuable scientific observations and for his sledge journeys with Mr. Jackson in Franz Josef Land; the Gill memorial to the Hon. David Carnegie for his journey across the Western Australian desert from Coolgardie to Hall's Creek and back by a different route, thus traversing the desert twice; the Cuthbert Peek grant to Dr. Nathorst for his important scientific exploration of the Spitzbergen Islands and the seas between Spitzbergen and Greenland; the Back grant to Captain Sykes for his three journeys through Persia, during which he has made important corrections and additions to the map of that country and done much to clear up the geography of Marco Polo. These honors will be awarded at the anniversary meeting of the Society on June 5th, and at the same time the American Ambassador will present to Sir John Murray the gold medal of the American Geographical Society for his valuable contributions to scientific geography.

THE 30th annual meeting of the Iron and Steel Institute of Great Britain was opened on May 4th in the hall of the Institution of Civil

Engineers, Westminster. The chair was occupied in the first instance by the retiring President, Mr. Edward P. Martin, who introduced his successor, Sir William Roberts-Austen, who delivered the inaugural address. The report of the Council for the past year was read by the Secretary, Mr. Bennett H. Brough, and showed that during 1898 the number of members was increased by 98, the total number on the roll at the end of the year being 1,579. With 57 members elected at the present meeting the total numerical strength of the Institute was brought up to 1,579. To the list of honorary members the names of King Oscar II. of Sweden and Norway and Baron Gustav Tamrén, Governor-General of Stockholm and President of the Association of Swedish Ironmasters, were added during the past year. The annual dinner was held on the evening of May 4th, at which speeches were made by the Chairman, Sir William Roberts-Austen; Mr. Horace Seymour, Deputy-Master of the Mint; Sir William White, Director of Naval Construction; Sir H. Brackenbury, Director-General of Ordnance; Professor Rücker, Lord Lister, Lord Strathcona, Mr. Preece and others.

THE Sixth International Congress on Commercial Education opened at Venice on May 4th, under the presidency of Signor Pascolato. It will next meet at Paris on August 26, 1900.

THE report of the Council presented at the seventieth anniversary meeting of the Zoological Society of London stated that the number of Fellows on December 31, 1898, was 3,181, showing an increase of 27 during the past year and the number of Fellows on the roll was in excess of what it had been in any year since 1885. The total income during the past year had been £29,208, being £495 more than that of 1897, and £3,357 in excess of the average during the preceding ten years. The increase in the income was attributable to the large amounts received for admission fees, compositions and subscriptions, and also to the augmentation of the miscellaneous receipts caused by a contribution of Mr. Walter Rothschild M.P., towards the outlay on the new tortoise house, built in 1898. The ordinary expenditure of the Society for 1898 had amounted to

£25,979, which was an increase of £649 over that for 1897. A sum of £3,718 had also been paid to extraordinary expenditure, having been devoted mainly to the construction of new buildings in the gardens and to the acquisition of a young male giraffe, which, although it arrived in apparently good health, did not, unfortunately, live long in the gardens. After payment of the ordinary and extraordinary expenditure a balance of £1,584 had been carried forward. The number of visitors to the gardens in 1898 had been 710,848, being 6,707 less than the corresponding number in 1897. The number of animals living in the gardens on December 31st last was 2,656, of which 818 were mammals, 1,363 birds and 475 reptiles and batrachians.

CONSUL-GENERAL HOLLOWAY, of St. Petersburg, sends to the Department of State, under date of March 28, 1899, translation of an article from the 'Novoe Vremia' of the 17th instant, referring to the first trip of the new 10,000-ton ice boat recently built in England for the purpose of keeping the ports of St. Petersburg and Riga open during the winter months, as follows: The ice boat *Ermak* arrived at Cronstadt March 5th-17th. This boat was made after plans prepared by Admiral Makaroff and built in England. Owing to the fogs, it had to remain two days in Belt. Near Reval it met with very thick ice, but still continued moving at 7 knots per hour. Near Seskei it met with large fields of ice, from 9 to 10 feet above the water line. Here the *Ermak* could not move on; but, with the aid of its machinery, it acquired a swinging motion, and the water running out of a special apparatus in the boat melted the ice under the vessel, which moved on, dispersing the ice mountains. The ice boat presses on the ice with its prow; the screw that is under it lets out water, which softens the ice, and the movement of the screw makes the ice go under it and breaks it into rather small pieces. This ice boat has no keel and should, therefore, be subject to great rolling, but, in order to avoid this, there is a receptacle in the hull of the vessel, filled with water, which is arranged in such a way that the water does not allow the vessel to sway too much one side or the other, and keeps it in equilibrium. The

boat was met at Cronstadt with great triumph and music. Hundreds of people went out to meet it, running alongside of it on the ice. The ice boat belongs as yet to the Ministry of Finance. It is at the same time a passenger boat, a freight boat and a tug boat. It can accommodate nineteen first-class passengers, for which it has a fine cabin, decorated with imperial portraits, with double windows, double illuminators, and a special ventilator, which lets warm air into the cabin. The walls are of oak. The boat is lighted by electricity. On March 31st the Consul-General adds: "The new iceboat *Ermak* left Cronstadt on the 25th of March and opened the port of Reval, plowing through from 16 to 18 feet of ice, releasing three commercial steamers that were frozen fast some distance from the shore. On the morning of March 27th the *Ermak* left Reval, clearing the way to the sea for four vessels. During the first four days of the *Ermak's* arrival at Russian ports she released sixteen vessels from the ice and opened the way for them to proceed to sea."

UNIVERSITY AND EDUCATIONAL NEWS.

MR. SAMUEL CUPPLES has increased his gift of \$150,000 for a building for Washington University, St. Louis, to \$250,000 for two buildings.

MR. MAXWELL SOMMERVILLE has presented to the University of Pennsylvania his collection of engraved gems and ethnological collections, said to be of the value of \$600,000.

THE *Jewish Chronicle* publishes full details of the bequests of Baroness de Hirsch. They amount in all to about \$9,000,000, which is distributed chiefly among Hebrew charities throughout the world. The bequests include 7,000,000 fr. to the Teachers' Training School of the Hebrew Alliance at Paris and 3,000,000 fr. for elementary education in Galicia.

NECESSARY alterations are being made in the physical laboratory of Western Reserve University in order to erect an observatory upon it. The University has recently received a gift of a ten-inch refractor made by Messrs. Warner and Swasey. Mr. Samuel Mather, the donor of the laboratory, has offered to bear the expense of mounting the instrument.

HARVARD University has recently received two collections of shells which are at present being made ready for exhibition. One of these, given to the University by the heirs of Warren Delano, was made by Mr. Ballestier at the beginning of the present century and consists of specimens from the East Indies. The other is a very complete collection of American land shells made by Mr. E. Ellsworth Call.

THE Committee of Birmingham University announced, on May 18th, that the conditions attached to Andrew Carnegie's offer of \$250,000 to the institution had been fulfilled, the subscriptions having reached \$1,272,900. Mr. Chamberlain had also received a letter from the anonymous donor who had already given \$187,500, offering an additional \$62,500 if the proposed endowment is increased to \$1,500,000.

IN view of the large increase in the number of students attending the Institute of Technology at Darmstadt, the sum of 1,137,000 Marks has been appropriated to enlarge the buildings and 45,700 Marks for equipment. In addition to these improvements, an engineering laboratory will be erected at a cost of 270,000 Marks.

OXFORD and Cambridge Universities have offered to admit to the privileges of affiliation graduates of McGill University and all matriculated students who have completed two academical years of study at McGill and have passed the intermediate examination for the degree of Bachelor of Arts. These terms, if accepted by the McGill corporation, will permit an undergraduate who has passed the intermediate examination to take his degree at Oxford or Cambridge in two years.

A COMMISSION has been established to take charge of the relations between the City and the University of Paris. It consists of members of the Municipal Council and officers of the University, with M. Gréard, Vice-Rector of the University, as President.

DR. HUGO MÜNSTERBERG, professor of psychology at Harvard University, will deliver the commencement address at the Women's College of Baltimore, his subject being 'The Relation of Psychology to General Education.'

PROFESSOR ALFRED CORNU, the eminent French physicist, has been appointed Reader in Cambridge University for the coming year.

PROFESSOR EDWARD H. KEISER, for the fourteen years professor in chemistry at Fawcett College, has accepted the professorship of chemistry in Washington University to succeed Professor Charles B. Sanger, who has been appointed to a position in the chemical department of Harvard University.

DR. HOWARD AYRES, professor of biology at the University of Missouri, has been elected President of the University of Cincinnati.

DR. F. C. FERRY has been appointed assistant professor of mathematics, and Dr. W. Waid, instructor in physics, in Williams College.

DR. C. E. ST. JOHN has been appointed professor of physics and astronomy in Oberlin College, and Dr. L. Dickson has been promoted to a professorship of mathematics in the University of California.

DR. F. H. SAFFORD, instructor in mathematics at Harvard University, has been appointed assistant professor of mathematics and mathematical physics at the University of Cincinnati to succeed Professor L. A. Bauer, who was appointed as Chief of the newly-established Division of Terrestrial Magnetism of the U. S. Coast and Geodetic Survey we announced last week.

THE table at the biological laboratory at Coxsack, New York, provided for by the John Jones Scholarship of Columbia University, has been filled by the appointment of Mr. John H. Torrey. H. C. Surface, of Cornell University, has been chosen to be the first beneficiary of the Dyckman fund for biological research. Mr. Surface is well known for his work on the fishes of New York State.

THE Babbot Fellowship of Vassar College has been awarded to Miss Anne Moore, assistant in biology. Miss Moore will spend next year studying biology at Chicago University.

At the University of Berlin, Dr. S. Schwendener, professor of botany, has celebrated his 70th birthday, and Dr. H. Munk, professor of physiology, his 60th birthday.

SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; J. LE CONTE, Geology; W. M. DAVIS, Physiography; HENRY F. OSBORN, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BERRY, N. L. BRITTON, Botany; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; J. McKEEN CATTELL, Psychology; DANIEL G. BRINTON, J. W. POWELL, Anthropology.

FRIDAY, JUNE 2, 1899.

THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.—SECOND CONFERENCE.

CONTENTS:

<i>The International Catalogue of Scientific Literature—Second Conference (I):</i> DR. CYRUS ADLER....	761
<i>Color-Weakness and Color-Blindness:</i> DR. E. W. SCRIPTURE.....	771
<i>American Climatological Association:</i> DR. GUY HINSDALE.....	774
<i>Scientific Books:—</i>	
<i>Some Smithsonian Publications:</i> F. A. BATHER.	
<i>Creighton's Introductory Logic:</i> DR. GEORGE REBEC.....	775
<i>Scientific Journals and Articles:.....</i>	783
<i>Societies and Academies:—</i>	
<i>American Physical Society:</i> PROFESSOR A. G. WEBSTER. <i>The Biological Society of Washington:</i> DR. O. F. COOK. <i>Geological Conference and Students' Club of Harvard University:</i> J. M. BOUTWELL. <i>The Academy of Sciences of St. Louis:</i> PROFESSOR WILLIAM TRELEASE.....	784
<i>Discussion and Correspondence:—</i>	
<i>The Telepathic Question:</i> PROFESSOR E. B. TITCHENER.....	787
<i>Current Notes on Meteorology:—</i>	
<i>Climatic Changes on the Pacific Coast; Wave Clouds; Recent Publications:</i> R. DEC. WARD.	787
<i>A Bryological Memorial Meeting.....</i>	788
<i>Scientific Notes and News.....</i>	788
<i>University and Educational News.....</i>	791

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

I.

IN SCIENCE for August 6, 1897 I gave an account of the steps which led to the holding of the first Conference on an International Conference of Scientific Literature, and a somewhat detailed description of the Proceedings of the Conference.* At the invitation of the editor of SCIENCE, I shall describe below the work done since that time to reach a working plan for this most important undertaking.

The first Conference, in July, 1896, had reached certain definite conclusions, which may be briefly stated as follows: (a) That it was desirable to publish a catalogue of scientific literature by means of some international organization; (b) that the catalogue was to be primarily for the scientific investigator; (c) that papers were to be indexed according to subject-matter; (d) that the catalogue should comprise all published original contributions to science; (e) that the catalogue be issued in the double form of slips and books.

The Conference passed a resolution to the effect "that the Royal Society be requested to form a committee to study all questions relating to the Catalogue referred to it by the Conference, or remaining undecided at the close of the present sittings of the Confer-

* The article was also published in separate form.

ence, and report thereon to the governments concerned." It was also left to the Committee "to suggest such details as will render the Catalogue of the greatest possible use to those unfamiliar with English."

In accordance with the terms of these resolutions, the Royal Society appointed, in November, 1896, a Committee, with Professor Henry E. Armstrong as Chairman, which presented a report on March 30, 1898. This report consisted of a series of proposed regulations for the conduct of the Catalogue, a provisional financial statement, and schedules of the various sciences. Inasmuch as this report formed, in a large measure, the basis of the discussion and resolutions of the second Conference, it seems desirable to present an outline of its contents.

Schedules of Classification. Authorized schedules are to be prepared for the several branches of science included in the Catalogue; each of these to be indicated by a Roman capital letter known as the Registration letter; the division in each schedule to be indicated by numerical symbols called Registration numbers; when desirable, an alphabetical index of the several headings be appended to each schedule.

Card Catalogue. For each communication to be indexed at least one slip called Primary slip shall be prepared containing title entry, subject entry, registration symbols and significant words. These slips are to be prepared by the bureaus established in the various countries (regional bureaus), which will transmit them to the Central Bureau as rapidly as possible. When a primary slip bears more than one subject entry or registration number copies of secondary slips shall be prepared. Slips of standard size, stoutness and color are to be printed for issue to subscribers, each slip to be revised by an expert official of the Central Bureau.

Book Catalogue. At determined regular intervals the Central Bureau shall issue, in

book form, an author's and subject index of the literature published within that period. This Book Catalogue shall be obtainable in parts corresponding to the several sciences or in divisions of such parts. After the first issue of the Book Catalogue the Committee of Referees are to be consulted as to the desirability of making changes in classification.

International Council. This shall be constituted by one representative of each Regional Bureau and shall be the governing body of the Catalogue. It shall appoint its own Chairman and Secretary, and shall meet in London at least once in three years. This Council is to be the supreme authority for all matters belonging to the Central Bureau, and is to report its doings to the Regional Bureaus.

International Committee of Referees. The International Council shall appoint, for each science included in the Catalogue, five persons skilled in that science to form an International Committee of Referees. The members shall be appointed in such a way that one retires each year. These committees shall be consulted by the Director of the Central Bureau on all questions of classification not provided for by the regulations.

The Central Bureau is to be composed of a paid staff, consisting of (1) a General Director, (2) for each branch of science a skilled assistant, (3) clerks. There is also to be a Consultation Committee, consisting of persons representing the several sciences and residing in or near London.

The next portion of the report is explanatory of the schedules of classification. It expressly stated that the schedules are put forward as illustrations of feasible methods of classifying the several sciences and not as final or authoritative. A detailed account of the method of the work of the Central Bureau is given, which need not be entered upon here.

Financial Statement. It is estimated that about 40,000 communications will have to be analyzed and indexed per annum. If there are on an average 3 analytical slips for each entry this would make 160,000 slips per annum, or about 530 for each working day. It is further estimated that the Book Catalogue will amount to 16 volumes per annum.

Book Catalogue. The estimated cost of the Book Catalogue (counting an edition of 500 copies) is £5,450, which would be covered by a subscription to 350 sets at £1 per volume.

Slips or Card Catalogue. If but a single or primary slip is considered the additional expense would be £3,076, and allowing £1,000 saving on printing the book it would require 130 complete subscriptions at £16 to cover this expense. If the full, or analytical-slip, catalogue be prepared 120,000 additional slips would have to be dealt with per annum and 171 institutions would have to pay £35 to cover the cost, which would, however, slightly reduce the cost of the primary slips. It would, of course, be provided that portions of the catalogue could be subscribed for separately. The following table furnishes a clear idea of the expenses and charges :

	Total cost.	Least remunerative number of complete subscriptions.	Average subscription to single science.	Maximum subscription to single science.	Complete subscription.
Book Catalogue (1,000 copies).....	£5,590	£350	£1 0 0	£2 0 0	£16
Primary Slip Catalogue (200 copies).....	3,075	130	1 0 0	1 17 6	15
Secondary Slip Catalogue (200 copies)....	5,992	171	2 5 0	4 7 6	35
	£14,657	—	£4 5 0	£8 5 0	£66
Less saving on use of Linotype	1,000				
	£13,657				

The Committee expressed the opinion that if the Book Catalogue alone were published the subscription might be expected

to cover the expenditure, whereas if the Slip Catalogue were published as well the expenditure would probably be beyond the sum which can reasonably be expected to be raised.

In view of this conclusion the Committee raises the question as to whether a primary slip might not be sufficient, whether a monthly bulletin in book form would serve the purpose, or, should the entire Slip Catalogue be desired, whether a 'sustenance' fund could be raised to meet the difficulty. The need of a guarantee fund amounting to about £6,000 is also pointed out.

The remainder of the report is taken up with the schedules, which cannot be discussed here. Anticipating somewhat before coming to the Conference, it may be well to mention that in November, 1898, the Committee issued a memorandum on the systems of classification and registration proposed. It is explained that the minute subdivision was adopted because if the cards accumulated several years the number under each head might grow so large as to make it a work of great labor to search through them. Should the Card Catalogue be abandoned the number of divisions might be considerably reduced in the annual volumes, though it would be desirable

to retain them in the volumes ranging over decimal periods, if such were published.

System of Registration.—Each principal

science is indicated by a letter. The divisions of each science are numbered. These divisions can be subdivided by the use of significant words or symbols.

This plan is explained in detail and defended. As a further evidence that the Committee did not consider its schedules final it has issued a revised schedule of Physiology (Animal).

THE CONFERENCE.

The second Conference, which, like the first, was summoned by the British government, was attended by the following delegates, many of whom had participated in the first Conference:

Austria. Professor L. Boltzmann (Kaiserliche Akademie der Wissenschaften, Vienna).

Professor E. Weiss (Kaiserliche Akademie der Wissenschaften, Vienna).

Belgium. Chevalier Descamps (Membre de l'Académie Royale de Belgique, Président de l'Office International de Bibliographie, Brussels).

M. Paul Otlet (Secrétaire-General de l'Office International de Bibliographie, Brussels).

M. H. La Fontaine (Directeur de l'Office International de Bibliographie, Brussels).

France. Professor G. Darboux (Membre de l'Institut de France).

Dr. J. Deniker (Bibliothécaire du Muséum d'Histoire Naturelle).

Professor E. Mascart (Membre de l'Institut de France).

Germany. Professor Dr. Klein (Geheimer Regierungsrath, University of Göttingen).

Hungary. Dr. August Heller (Librarian, Ungarische Akademie, Buda-Pesth).

Dr. Theodore Duka (Member of the Hungarian Academy of Sciences).

Japan. Professor Einosuke Yamaguchi (Imperial University of Kyoto).

Mexico. Señor Don Francisco del Paso y Troncoso.

Netherlands. Professor D. J. Korteweg (Universiteit, Amsterdam).

Norway. Dr. Jürgen Brunchorst (Secretary, Bergenske Museum).

Sweden. Dr. E. W. Dahlgren (Librarian, Königl. Svenska Vetenskaps Akademie, Stockholm).

Switzerland. Dr. Jean Henry Graf (President, Commission de la Bibliothèque Nationale Suisse.)

Dr. Jean Bernoulli (Librarian, Commission de la Bibliothèque Nationale Suisse).

United Kingdom. Representing the Government: The Right Hon. Sir John E. Gorst, Q. C., M. F. R. S. (Vice-President of the Committee Council on Education).

Representing the Royal Society of London:

Professor Michael Foster, Sec. R. S.

Professor Arthur W. Rücker, Sec. R. S.

Professor H. E. Armstrong, F. R. S.

Sir J. Norman Lockyer, K. C. B., F. R. S.

Dr. Ludwig Mond, F. R. S.

United States. Dr. Cyrus Adler (Librarian, Smithsonian Institution, Washington).

Cape Colony. Roland Trimen, Esq., F. R. S.

India. Lieut.-General Sir R. Strachey, G. C. S. F. R. S.

Dr. W. T. Blanford, F. R. S.

Natal. Sir Walter Peace, K. C. M. G. (Agent-General for Natal).

New Zealand. The Hon. W. P. Reeves (Agent-General for New Zealand).

Queensland. The Hon. Sir Horace Tozer, K. C. M. (Agent-General for Queensland).

The Conference met Tuesday, October 1 1898, in the rooms of the Society of Antiquaries (Burlington House) the rooms the Royal Society not being available, as they were undergoing repairs. Sir John Gorst, President of the previous Conference, took the chair, and on motion of Professor Darboux (France) was elected President. Professor Korteweg (Netherlands) was elected Secretary for the German language. M. La Fontaine (Belgium) for French, and Professor Armstrong for English. Three short-hand reporters, one for each language assisted the Secretaries.

Professor Michael Foster then stated that the invitations to the Conference had been issued through the Foreign Office, and gave a list of the acceptances.* The Greek government regretted that they were unable to appoint delegates;† the Russian government did 'not consider it necessary to be represented by a special delegate.' The Danish government took the same view

* List is given above.

† The Russian government has since requested the appointment of a representative on the International Committee.

being satisfied that it could follow the matter from the verbatim reports issued. The German government, on October 4th, requested a postponement owing to the difficulty of appointing delegates, but it was not possible to arrange for this. Professor Klein, of Göttingen, representing Germany, arrived the second day of the Conference.

The time of meeting was then arranged and a resolution agreed to 'That each delegate shall have a vote in deciding all questions brought before the Conference,' it being understood that the decisions of the Conference did not bind the respective governments. It was further agreed that English, German and French be the official languages of the Conference, but that any delegate might employ any other language, provided he supply a written translation into one of the official languages.

Professor Foster then formally laid before the Conference, on behalf of the Royal Society, the report summarized above, and Professor Rücker, in explaining the report, gave it as his opinion that the secondary cards entailed too great an expenditure and should be given up. Dr. Deniker (France) thought the question to be discussed was whether it was better to publish the Catalogue in the form of volumes or cards.

Professor Darboux was opposed to giving up cards which rendered great service to scholars. He thought it best to discuss the scientific questions first and leave this matter to the body which would be charged with the actual workings of the Catalogue.

M. Otlet (Belgium) considered that the order of subjects was threefold: (1) scientific, (2) technical—relative to the method of employing the cards, and (3) financial.

Dr. Graf (Switzerland) dissented, holding that the matter should be taken up in the order indicated by the Royal Society, inasmuch as the financial questions depended upon whether the Catalogue should be issued in both book and card form. He added

that his government had given him instructions to advocate the double form.

Dr. Heller (Hungary) also expressed himself in favor of the double form. Dr. Brunchorst (Norway) agreed in principle, but thought at the beginning the Catalogue could only be issued in book form. Professor Boltzmann (Austria) thought that for the present only the book form and primary slips were feasible.

Professor Darboux pointed out that it was at least necessary for the various Bureaus to prepare the Catalogue in slip form and send it to London. The financial question was: Could this Card Catalogue be published? If it could it would be done; if not it could be consulted in London.

Dr. Adler pointed out that if the complete Card Catalogue were published the subscription fee would by no means cover the entire cost to a library; an additional sum for furniture to provide for it, as well as for the arrangement and care would have to be taken into account, as well as the space required, making the total cost of the whole Catalogue and its maintenance to each institution subscribing about £200 per annum.

Dr. Deniker thought the statement as to the space, cost, etc., exaggerated, and formulated the proposition: "The Conference decides in principle for the publication of the Catalogue in the double form of volumes and cards;" after further discussion this resolution was agreed to.

The report of the Committee of the Royal Society was then taken up *seriatim* and it was agreed after a brief discussion as to the form 'That schedules of classification shall be authorized for the several branches of science which it is decided to include in the Catalogue.'

Professor Foster then moved that "Each of the sciences for which a separate schedule of classification is provided be indicated by a Roman capital letter (hereafter called

a registration letter) as a registration symbol, namely, as follows :

- A. Mathematics.
- B. Astronomy.
- C. Meteorology.
- D. Physics.
- E. Crystallography.
- F. Chemistry.
- G. Mineralogy.
- H. Geology (including Petrology).
- J. Geography.
- K. Paleontology.
- L. Zoology (including Anatomy).
- M. Botany.
- N. Physiology (including Pharmacology and Experimental Pathology).
- O. Bacteriology.
- P. Psychology.
- Q. Anthropology."

Dr. Bernoulli (Switzerland) pointed out that the plan of dividing the Natural History sciences into several groups was a departure from systems already in existence.

Dr. Heller (Hungary) did not entirely agree as to the wisdom of the division; he pointed out that in the course of years certain institutions and publications had grown up which treated several of the subjects named. Under this plan the publications would be entirely separated. If, however, this was necessary he would advocate a still further division and suggested the separation of Anatomy from Zoology.

Professor Weiss (Austria) suggested that the question be divided, first, as to whether registration letters be used, and second, how the several sciences should be arranged among them. This being agreed to, the original proposition was withdrawn.

Professor Darboux pointed out that in the list of sciences Geography was given, whereas it was his understanding that the first Conference intended to include only mathematical and physical geography.

Professor Weiss indicated the difficulty in agreeing upon an absolutely definite list, due partly to the different development

some of the sciences had taken in England and on the Continent. The specialists of the Vienna Academy had suggested that human anatomy should be separated from zoology. No doubt similar suggestion would come from other countries on special points. He, therefore, advised that a small commission be formed by the Royal Society, which might consult various specialists and secure a coordinated scheme.

Dr. Deniker thought too much stress was being laid on the matter. It was his opinion that if Pharmacology were to be introduced it should be as a separate science with a special letter, pointing out at the same time that it was an applied science and not in accordance with the original program, which was to include only pure science.

M. Otlet propounded several questions in the hope of eliciting information as to how the work of the Committee had been done, and M. Darboux pointed out that the science of Mechanics was put down as a section of Physics. He considered Mechanics a fundamental science and thought it should have an independent section.

Professor Armstrong stated in reply that practical considerations had come into play. For each separate science a separate series of boxes would have to be kept, and they provided as many letters as they thought separate boxes would be required. The separate letters were prepared purely for office purposes. The scheme of Geography was, he admitted, purely from the English point of view. The Committee had no communication with foreign academies, but consulted individuals. It desired, however, that foreign individuals and academies should have the opportunity of examining the schedules. Professor Michael Foster stated that the sub-committee which drew up the schedule for Physiology put itself in communication with distinguished and practiced physiologists in other lands, and

that they were now attempting to put the schedule into practical use. He added for the whole Committee that they did not maintain the schedules in their entirety.

Professor Armstrong pointed out that the introduction of a special science like Mechanics was contemplated and was entirely possible under the scheme. He quoted the following from the report: "It will be necessary to provide a separate volume, to be sold apart, for each science to be distinguished by a registration letter; and in some sciences, Zoology in particular, there will, doubtless, be a demand for separate volumes dealing with special sections of a science." "The extent to which the subdivision of the Book Catalogue into parts is carried will necessarily depend on the demand arising in practice."

Mr. Otlet thought that the matter had been somewhat cleared up and favored the subdivision referred to. Anthropology, he said, comprehended nearly all the sciences not included in the other sciences—such as theology, anthropometry, questions relative to the various human races, their industrial occupations, etc.—the concomitant subjects would be nourishment, and hence agriculture, costume, hunting, navigation, etc. Under communication of ideas grammar and the sciences connected with it would come in history, religion, superstition, sociology, slavery, social organizations, all of which would have to be considered.

M. Korteweg said that the subdivision of sciences would also create great difficulties; he favored the exclusion of Political Geography. Professor Darboux said that he was in practical accord with what had been said, but still thought that Mechanics should form a separate class. Dr. Graf desired that Anatomy be separated from Zoology and be placed in a separate class. Dr. Boltzmann suggested that the first class be General Science. Meteorology, he

thought, should be connected with Physical Geography. Chemistry should stand between Crystallography and Mineralogy. Anatomy should be in a separate class. The questions raised concerning Mechanics and Anthropology were of great importance, but he thought that the Conference was not ripe for their solution.

Professor Armstrong said that the question raised about Mechanics was a practical one, whereas the definition of the limits of Geography and Anthropology was a scientific matter, and suggested that the latter be dealt with first.

Dr. Heller suggested, instead of the term Geography, that of Geo-Physics; this would include physical geography and meteorology and exclude political geography. He thought, too, that experimental psychology might be included under Anthropology.

Professor Armstrong, to bring the discussion to a conclusion, moved that Geography be limited to mathematical and physical geography, to the exclusion of political and general geography. In doing so he pointed out, however, that this action might lead to the Geographical Catalogue, being of no use to the general geographical student and not being subscribed for.

Dr. Adler stated that travels were of great importance to naturalists and anthropologists and had been included in the Bibliography published by the German Geographical Society. Dr. Duka also favored their retention, but Dr. Mond dissented, holding that this view deviated from the original intention of the Catalogue. The motion to limit the scope of Geography as above stated finally prevailed.

After a brief discussion by Professors Armstrong, Boltzmann, Darboux and Deniker, a resolution was adopted that after Zoology, Anatomy be entered on the list as a separate subject.

The following resolution was then unanimously agreed to:

"It is proposed that a separate schedule be provided for each of the following branches of science: Mathematics, Astronomy, Meteorology, Physics, Crystallography, Chemistry, Mineralogy, Geology (including Petrology), Geography (Mathematical and Physical, excluding Political and General) Paleontology, Anatomy, Zoology Botany, Physiology (including Pharmacology and Experimental Pathology), Bacteriology, Psychology and Anthropology."

The next question taken up was that of the Registration Symbols. Professor Darboux objected to voting on a resolution naming specifically the letters for each science. He thought that it was a detail of execution and would change the character of the Conference if matters of such secondary importance were discussed.

Professor Armstrong, in accordance with this suggestion, presented a motion as follows: "That each of the sciences, for which a separate schedule of classification is provided, shall be indicated by a symbol." Professor Korteweg thought that the question involved that of many different systems of classifications and various schemes of symbols, but Professor Armstrong pointed out, in reply, that if the resolution passed it would not bind the bureau to any particular symbols. M. Deniker thought that the question did not have the importance attributed to it—that the symbols were simply a practical scheme for securing order in the publication and handling of the cards. M. Otlet was inclined to lay more stress on the question; he thought they were not simply a matter for the convenience of the clerks, but would become useful to librarians and scientific men. The resolution was then adopted.

The next question taken up was the regulations concerning the preparation of the cards or slips. These regulations refer not to the Catalogue itself so much as to the preparation of the Catalogue. Professor Foster moved that, "For each communication to be indexed, at least one slip, to be called a 'Primary slip,' shall be prepared,

on which shall be either printed, or type written, or legibly hand-written in Roman script: Title entries, the author's name and the full title of the communication in the original language alone if the language be either English or French, German or Latin." In the case of other languages the title shall be translated into English, or such other of the above four languages as may be determined by the Regional Bureau concerned; but in such case the original title shall be added when the language is one which can be conveniently printed. Professor Foster presented this with an amendment to the effect that Italian should be added to the languages named.

Dr. Brunchorst thought it best to have but three languages and omit Latin and Italian, holding that there were very few publications in Latin and that its introduction was not important. He further made the interesting statement that within a few years the Latin language will have disappeared from use in Norway, and that there would probably be no public school in Norway in which Latin could be studied. Professor Rücker stated that, although the title of a paper might be given in Latin, it did not follow that the subject-entry should be in that language. Professor Foster added that Latin was introduced chiefly in the interest of zoologists. Mr. Triman, delegate from Cape Colony, thought it important to retain it. Dr. Adler held that every title should be given in the language in which the paper is written, without any exception whatsoever. Professors Foster and Armstrong both pointed out that some translation of titles was necessary, but Dr. Adler stated that, while translations of titles might be given when necessary, the original title should also be given, either in the original character or in a transliteration. It was agreed to omit Italian but retain Latin, and the first part of the resolution was then carried.

The next proposition under discussion was as follows: "In the case of other languages the title shall be translated into English, or such other of the above five languages as may be determined by the Regional Bureau concerned, but in such case the original title shall be added when the language is one which can be conveniently printed."

Dr. Adler suggested that instead of the last phrase the resolution shall read: "In such cases the original title shall be added; if convenient it shall be printed in the original script, otherwise in Roman script." Professor Foster inquired of the Japanese delegate whether the Japanese language could be conveniently written in Roman script and whether educated Japanese could read transliterations of Japanese, and received an affirmative reply. The amendment was then unanimously agreed to.

The question arose in connection with this matter as to the meaning of the term 'regional bureau,' and Professor Rücker explained that it had been decided to employ this term instead of the word 'National' because it might happen that one nation, as, for instance, the British Empire, may have more than one bureau, whereas some of the smaller countries, like Holland and Belgium, might unite in a single bureau. If there was any objection, he said, to 'regional,' the term 'Collecting Bureau' might be employed.

M. Otlet desired to add to the resolution the phrase 'to diminish the number of necessary translations,' which he pointed out as being extremely desirable, but the President thought this question might be more conveniently raised at a later stage. The entire resolution as amended was then carried.

Professor Foster then moved that "the title shall be followed by every necessary reference, including the year of publication, and such other symbols as may be determined."

The next resolution was "Subject-entries, indicating, as briefly as possible, the particular subjects to which the communication refers. Every effort shall be made to restrict the number of these subject-entries. Such subject-entries shall be given only in the original language of the communication if this be one of the five previously referred to, but in other cases in English, or in such other language as has been used in translating the title."

M. LaFontaine pointed out what seemed to him certain inconsistencies in subject-entries presented in the schedules, and thought that the idea of the subject-entries was not fully understood, but both Professors Foster and Armstrong combatted this idea. Dr. Adler pointed out the difficulty of grouping the subject-entries satisfactorily in view of the fact that the analysis could be made in five languages, but Professor Rücker explained that the alphabetical arrangement would be according to English words.

Chevalier Descamps stated that the book issue would require the repetition of titles, and that on the whole it would be more economical to repeat them entire. To this suggestion Professor Armstrong agreed, pointing out that its necessity had been recognized by the Committee.

M. Deniker inquired as to the relative value of the terms subject-entry and catchword. Was the subject-entry to be subordinated to the significant word, or *vice versa*? Professor Foster explained that the subject-entry was to give an idea what the paper was about, the symbols to aid in keeping the Card Catalogue in order, and the significant words to aid the student who did not carry the symbol in his mind.

M. Deniker replied that it was now clear to him that what was proposed was not simply a catalogue, but an analysis. What limits he asked, would be imposed. Thus four or five subject-entries might be given

in describing a single memoir. While recognizing the usefulness of these, he thought some limit would have to be considered.

Professor Foster replied that for three years past the Royal Society had requested each author to give an analysis of his paper in such form that it might serve as a subject-index, and that in a large majority of cases it had been found possible to limit the analysis to three subject-entries.

Professor Rücker pointed out that significant words would serve as a sort of temporary expedient where a sudden interest sprang up in some new discovery, instancing the Röntgen rays. After some further discussion the resolution as to subject-entries was carried unanimously (the Belgian delegates abstaining from voting).

Professor Armstrong then moved that "registration symbols, in accordance with those in the schedules of classification, shall be entered upon the slips in some conspicuous manner, and upon a uniform plan." He explained that at the first Conference schedules in accordance with the decimal system had been prepared and submitted, and that the Conference had decided against them. The plan now proposed is distinctly not the Dewey system. The figures given have no absolute value, and are solely for the purpose of enabling librarians to sort the cards and arrange the material.

This point was emphasized by Professor Rücker, who stated that in a system in which the numbers had an absolute value the method was equivalent to starting a new language, and he did not believe that the average scientific man would learn a language for such a purpose.

Chevalier Descamps addressed himself to the question of classification. He recognized the serious attention which had been given to the subject by the Royal Society, but said that the Society was not the first to take up the study which had been pursued by a large

number of authors, men of science and practical men. To provoke a general debate on classification seemed inopportune. He had pointed out in 1896 the possibility of a bibliographical classification based on the decimal system. This did not meet with favor, and the Royal Society had endeavored to produce a purely scientific classification. For its labors it merited the most profound recognition, but he regretted that the Royal Society had not explained the ideas which underlay its schedules. To be good a bibliographical classification should be both stable and elastic. The adoption of a mixed system of symbols, and more especially the lack of identity of meaning of the same symbols in the different sciences, seemed regrettable. He saw no objection to giving symbols a definite significance.

The statement of Chevalier Descamps (of which the above is but a brief abstract) brought from Professor Rücker an argument which probably expressed the opinion of most of the scientific men present, and is accordingly given in full :

"I think it would be desirable if I say a few words with regard to the very interesting remarks with which Chevalier Descamps has favored us. I think we must all agree that the questions he has raised are questions of the greatest interest to any one who has attempted to take any share in a work of this sort. But I very much regret, speaking for myself, that I find myself at variance with him on several fundamental points. In the first place, he urges us to adopt the scientific system of classification, which shall not change from five years to five years, or ten years to ten years, but which shall hold good for all time, or for a very long period of time. One of the very great advantages of our system is that we recognize that science is a growing subject. The notation that fits it to-day will not fit it next year, or ten years hence. Let us

suppose scientific knowledge had sooner led us to recognize the close relation of electricity and light. Surely the mode of division would be quite different. The definition of Zoology before and after Darwin would have been different. A classification which then appeared to be scientific would now be recognized as inadequate. The very first thing we must recognize is that our scientific knowledge is imperfect and growing, and we must adopt a system capable of easy modification as our knowledge increases. Another point which Chevalier Descamps made was that we adopt different methods with regard to different sciences; in some cases the numbers are followed by symbols; in some cases the numbers are separated by a hyphen, and so on. We have gone into this question as scientific men, and, although perfectly ready to submit the result of our work to the criticism of other scientific men, we do believe that the plan that suits best one science will not suit another. Take one example. Take, for instance, Zoology. There is the question of arrangement of the subject in accordance with the species of animals, and the question of arrangement with regard to the geographical distribution. Here are two ideas to which there is nothing similar in physics or chemistry. It would be disastrous if we attempt to force all these sciences to adopt the same method. If two things are essentially different, we do not apply the same principles to both. In the last place, Chevalier Descamps says the main object of classification is to tell us where to find a particular object with which we are dealing. I do not much believe in the average memory of scientific men being able to grasp a large number of numbers. I believe it is much easier to find the place by using symbols, which are more distinct than a large number is from a small one. Significant words which are for temporary use have their own meaning. You find them

alphabetically. I do think, on the question of general principle, that it is very desirable that the Conference should express an opinion as to whether or not they think the symbols are to be devised in such a way as to help the memory or to find the place; secondly, whether they do or do not hold the view that the plan good for one science is good for all, and whether it is desirable to attempt to plan a scheme in the belief that it will hold good for all time."

Dr. Bernoulli said that after hearing the statements in favor of the two systems he wished to add that the decimal system was in actual working order in Switzerland, and that its practical utility had been demonstrated there. He considered it superior to the system proposed by the Royal Society, although originally he had been an opponent of the decimal system.

M. Deniker replied that it was necessary to consult an alphabetic index to use the decimal-system catalogue. He favored a methodical or subject catalogue alphabetically arranged.

CYRUS ADLER.

SMITHSONIAN INSTITUTION.

(*To be Concluded.*)

COLOR-WEAKNESS AND COLOR-BLINDNESS.

It is generally accepted as a well established fact that the traveling public is fully protected by the present tests for color-blindness to which railway employees and pilots are subjected. Yet several of the mysterious accidents that have occurred during the last two years might be explained on the supposition of color-blindness on the part of responsible lookouts. In fact, I believe myself in position to prove that persons of dangerously defective color-vision actually do pass the regular tests and obtain positions where their defects are continual dangers to public welfare.

In the first place, I have at the present time among my students one who is abso-

lutely perfect at the wool-test. He can match wools with incredible precision at any distance away; he is, nevertheless, color-blind. This case is typical of a class of persons with eyes abnormally acute for differences in color, but yet with only two fundamental sensations instead of three.

In the second place, I have had among my students those who possessed perfect color-vision for near objects or bright objects, but who were practically color-blind for weakly illuminated or distant objects. These persons possess the typical three fundamental color sensations, but have one of them weaker than the normal. A person of this kind may pass the wool-test with the utmost perfection if the test is performed close by, but will fail if the wools are removed to a distance of 20 or 30 feet. This peculiar defect I take the liberty of terming 'color-weakness.' The first student of this kind that I examined passed the wool-test close at hand and yet was unable to distinguish red and green lanterns a few hundred yards away. Cases similar to this have been reported by the British Marine Examiner, Edridge-Green. Among other cases he quotes a letter from an engineer containing the following statement: "I have been on the railway for thirty years and I can tell you the card-tests and wool-tests are not a bit of good. Why, sir, I had a mate that passed them all, but we had to pitch into another train over it. He couldn't tell a red from a green light at night in a bit of a fog."

To eliminate both these classes of persons we must have a method of testing on quite different principles from the usual ones.

In the first place, the sorting of delicate shades of colors, according to likeness, must be replaced by *naming certain fundamental and familiar colors*. The sorting of wools is a quite unusual and perplexing task to a man brought up in a railway yard and on shipboard. It puts a nervous man at quite

a disadvantage; it furnishes the unsuccessful candidate with the excuse that the judgment required was so unlike any he had made before that he failed from nervousness; and, finally, it is not a guarantee that all who pass are not color-blind. The naming of colors should—as Donders proposed—be rigidly required. The engineer or the pilot in his daily routine is not called upon to match colors, but to decide whether a light is red, green or white; he should be tested on just this point. The color-blind student referred to above who can pass the wool-test to perfection fails at once when called upon to name the wools. The naming of delicate and perhaps unusual shades should, however, not be required; the colors to be named should be the three familiar ones: red, green and white, so manipulated that every possible chance for confusion is presented.

The second necessity for eliminating danger is that of an absolutely certain test which shall detect both the color-blind and the color-weak. Acting on the basis of suggestions from the work of Donders and of Edridge-Green, I have devised a test that meets this requirement as well as the first one.

The instrument* which I have invented may be termed the 'color sight tester' or the 'color sense tester.' In general appearance it resembles an ophthalmoscope. On the side toward the person tested, Fig. 1, there are three windows of glass, numbered 1, 2 and 3, respectively. The opposite side of the tester, Fig. 2, consists of a movable disk carrying twelve glasses of different colors. As this disk is turned by the finger of the operator the various colors appear behind the three windows. At each movement of the disk the subject calls off the colors seen

* For those interested in obtaining the Color-Sight Tester I will say that I have made arrangements to have it made by the Chicago Laboratory Supply and Scale Co., Chicago.

at the windows. The windows, 1, 2 and 3, are, however, fitted with gray glasses. No. 1 carries a very dark smoked glass; all colors seen through it will be dark. No. 2 carries a piece of ground glass, showing all colors in full brightness. No. 3 carries a light smoked glass. There are thus thirty-six possible combinations of the colors. The twelve glasses are, however, mainly reds, greens and grays.

A suitable arrangement of the colors

reds, greens and grays simultaneously in a large number of different shades of intensity. The light of a green lantern, at different distances or in a fog, is simulated by the green behind the different grays; at the same time a white light is also changed. The color-weak person to whom weak green is the same as gray (white at a distance) is utterly confused and thinks that the weakened green is gray (white) and the dark gray is green.



FIG. 1.



FIG. 2.

gives direct simultaneous comparisons of reds, greens and grays of different shades. The well-known confusion by color-blind persons of dark greens with reds, greens with gray, etc., are exactly imitated, and the instrument gives a decisive test for color-blindness. Its peculiar advantage, however, lies in the fact that it presents

The actual test is performed in the following manner. The tester is held toward a window, at about $2\frac{1}{2}$ feet from the person tested. The operator begins with any chance position of the glasses, and asks the person tested to tell the colors seen through the three glasses, Nos. 1, 2 and 3. He answers, for example: "No. 1 is dark red; No.

2 is gray ; No. 3 is green." The operator records from the back of the tester the letters indicating what glasses were actually used. If he finds that A, D and G were opposite the glasses Nos. 1, 2 and 3 he records: A 1, dark red ; D 2, gray ; G 3, green. The disk is then turned to some other position ; the colors are again named, and the operator records the names used. For example, the result might be: "No. 1 is dark green ; No. 2 is white ; No. 3 is red ;" and the record would read: G 1, dark green ; J 2, white ; A 3, red. Still another record might give: J 1, dark gray ; A 2, red ; D 3, medium gray. Similar records are made for all combinations. Of course, the person tested knows nothing concerning the records made. A comparison with a list of the true colors for each position determines whether the test has been passed or not.

The three records just cited were all obtained from the red glass, A ; the gray glass, D ; the green glass, G, and the ground glass, J, in combination with the dark gray, No. 1 ; the ground glass, No. 2, and the medium gray, No. 3. Those familiar with color-blindness will notice that these combinations place side by side the colors most confused.

The records can be taken by any one, and, on the supposition that the record has been honestly obtained and that the instrument has not been tampered with after leaving the central office, the comparison is mechanical. There is none of the skillful manipulation required in the wool-test and none of the uncertainty attaching to its results. The only instruction given to the subject is: "Name the colors;" the results render the decision with mechanical certainty.

One of the testers is in use on one of the English railways, another on the central division of the New York Central Railroad. From the former I have not yet heard, but

the examiner on the latter reports that since using the tester he has found men who get through the wool-test, but are caught by the tester. On the other hand, he states that "the men examined say that this test is more like the signals they are used to seeing every day on the road, and is, therefore, fairer than to ask them to pick out a lot of delicately tinted pieces of yarn."

An experience of several years seems to justify the following claims for the color-sense tester:

1. It detects with unerring precision both the color-blind and the color-weak.
2. It is a perfectly fair test for the men concerned and injures no man by requiring an unfamiliar judgment.
3. It requires but a very small fraction of the time used on the wool-test.
4. Its decisions are self-evident and unquestionable.

E. W. SCRIPTURE.

PSYCHOLOGICAL LABORATORY,
YALE UNIVERSITY,
May 7, 1899.

AMERICAN CLIMATOLOGICAL ASSOCIATION.

THE sixteenth annual meeting of the American Climatological Association was held in New York City on May 9th and 10th at the hall of the New York Academy of Medicine. About fifty members were in attendance from all portions of the United States. Twenty-five papers were read upon subjects pertaining to climatology, hydrology and diseases of the respiratory and circulatory organs. These papers, which will appear in the annual volume of the Transactions, were as follows:

'Presidential Address,' by Dr. Beverley Robinson, of New York.

'Treatment of Consumption by Air and Light in Colorado,' by Dr. Charles F. Gardiner, of Colorado Springs.

'Intermediate Altitude for the Consumptive,' by Dr. B. P. Anderson, of Colorado Springs.

'The Contagiousness of Phthisis Pulmonalis,' by Dr. E. L. Shurly, of Detroit.

'Climate in Relation to Renal Disease,' by Dr. J. B. Walker, of Philadelphia.

'Climate as it affects the Skin and its Diseases,' by Dr. L. D. Bulkley, of New York.

'Hygienics of the Skin,' by Dr. L. D. Judd, of Philadelphia.

'Hydrotherapy in the Treatment of Insomnia,' by Dr. Irwin H. Hance, of Lakewood.

'Altitude and Heart Disease,' with report of cases, by Dr. R. H. Babcock, of Chicago.

'Prognosis in Chronic Valvular Affections of the Heart,' by N. S. Davis, Jr., of Chicago.

'Treatment of the Cardiac Asthenia of Pneumonia,' by Dr. H. L. Elsner, of Syracuse.

'Empyema from a Surgical Standpoint,' by Dr. John C. Munro, of Boston.

'Traumatic Rupture of the Heart, without Penetration of the Chest Wall,' with a case, by Dr. Richard C. Newton, of Montclair.

'Cold Wave of February, 1899,' by Dr. Guy Hinsdale, of Philadelphia.

Other papers by Drs. R. G. Curtin, C. F. McGahan, Harold Williams, F. H. Williams, E. O. Otis and V. Y. Bowditch, S. G. Bonney and H. S. Anders.

The annual dinner of the Association was held at the Manhattan Hotel, at which the President, Dr. Beverley Robinson, of New York, presided. On the following day the Association made a visit to the Loomis Sanitarium in Liberty, Sullivan County, New York. This institution was founded 1895 in memory of Dr. Alfred L. Loomis, the first President of the Association, for the treatment of tuberculosis. It has a favorable situation, 2,300 feet above tide, and is 120 miles from New York, on the Ontario and Western Railway. The remarkable success which has attended its work has been due in great measure to its physician in charge, Dr. J. E. Stubbert, liberally aided by the philanthropic support of Mr. J. Pierpont Morgan and the ladies who are associated in its management.

The scientific work of the Climatological Association tends to the better knowledge of the various American climates and health resorts and their employment in the treatment of disease.

The subject of tuberculosis is now receiving universal attention by the medical profession, and the public are being interested in measures looking to its prevention and restriction. It is encouraging to note that in all our large cities the mortality from this disease is gradually falling, and through societies of this kind knowledge is disseminated which affords the public greater protection and prolongs life. The resources of New York and Pennsylvania for the climatic treatment of pulmonary disease are not so well known as they should be. Neither are the mineral springs of the United States fully understood and intelligently used. The Transactions of the Climatological Association, now numbering fifteen volumes, have contributed in no small degree to the better knowledge of this extensive subject.

The following officers were elected for the ensuing year: President, Dr. A. Jacobi, of New York; Vice-Presidents, Dr. R. H. Babcock, of Chicago, and Dr. John W. Brannan, of New York; Secretary, Dr. Guy Hinsdale, of Philadelphia; Representative to the Executive Committee of the Congress of American Physicians and Surgeons, Dr. F. I. Knight, of Boston.

The next meeting will be held in Washington in May, 1900. GUY HINSDALE,
Secretary.

SCIENTIFIC BOOKS.

SOME SMITHSONIAN PUBLICATIONS.

Annual Report of the Board of Regents of the Smithsonian Institution, showing the operations, expenditures and conditions of the Institution to July, 1896. 8vo, lii + 728 pp., lxi pls. Washington, 1898. [Received by the Bureau of International Exchanges, January 25, 1899.]

Annual Report of the Board of Regents of the Smithsonian Institution, showing the operations, expenditures and conditions of the Institution for the year ending June 30, 1896. Report of the U. S. National Museum. 8vo, xxiv + 1108 pp., cxviii pls. Washington, 1898. [? 1899.]

Proceedings of the United States National Museum.

Volume XX. Published under the direction of the Smithsonian Institution 8vo, xii + 982 pp., xcvi pls. Washington, 1898. [? 1899.]

The activities and influence of the Smithsonian Institution have so extended that, instead of a modest Report of some hundred pages, its annual publishing output comprises several bulky octavo volumes. It is only 15 years since the Report of the United States National Museum was issued in distinct covers from that of the Smithsonian Institution. And now, to judge from the copy submitted for review, even this has reached limits that transcend the binder's art, and suggest that a further division into volumes would be beneficial. The line of division is obvious, for the Reports both of the Smithsonian and of the Museum owe their present thickness chiefly to the articles of general interest which are printed after the annual official statements. The public is, doubtless, grateful for these admirable articles, but its gratitude would be increased were they presented in more convenient form. The numerous readers that will be found for Mr. Thomas Wilson's richly illustrated account of 'Prehistoric Art' will not wish to be weighted with lengthy lists of accessions to the library, of new species described by the Museum staff, or of specimens sent to the Museum for identification. On the other hand, the professional museum-curator, who doubtless keeps the richly suggestive, one might say the classical, reports of the Smithsonian officials at hand for reference, will soon find his available space choked up with reprints of papers that he either has no longing for or already has in their original form.

The present Appendices to the Administrative Reports have, it is true, grown in a natural manner, on the one hand out of the summaries of progress in science that used to be attempted by the Smithsonian, and on the other hand out of short accounts or catalogues of specimens in the National Museum. Moreover, there may be something in the terms of the appropriation by Congress that renders the present mode of publication an official necessity. In such case a strong expression of the value attached at home and abroad to the several sections of these Reports,

and of the inconvenience resulting from their union, may do something to facilitate a change.

There is another argument in favor of the proposed separation. The information contained in these reports is as out of date as that in an ordinary science text-book. The world looks for more actuality in news that come from the United States. There is little in this 'Report of the U. S. National Museum for the year ending June 30, 1896' that the intelligent readers of SCIENCE did not know nearly three years since. We all knew that "Under an order issued by the President on May 6, 1896, the National Museum [with the other departments of the Smithsonian Institution] was made subject to the law regulating appointments and promotions in the Civil Service of the United States." We have read all about the government exhibit at the Atlanta Exposition in Brown Goode's contemporaneous report. We have mourned for Professor C. V. Riley and Mr. R. E. Earll, and, alas! for the writer of their obituary notices, here reprinted from SCIENCE. We have heard enough—perhaps too much—about Alaska and the seal fisheries of Bering Sea. There is little left but the statistics previously referred to. And since the letter of transmittal is dated August 8, 1896, why should we have to await these 284 pages for two years and a half? The reason appears to lie in the elaborate papers contained in Part II., which, it is obvious, could not have been published in 1896. Internal evidence shows that Mr. Thomas Wilson's attractive work on Prehistoric Art, of 340 pages, 75 plates and 325 text-figures, was not completed in manuscript before 1897. Mr. Stewart Culin's fascinating account of the origin of chess and playing cards has an introductory note dated August, 1897, and contains quotations from matter printed in that year. The equally interesting account of the exhibit of Biblical Antiquities at the Atlanta Exposition, by Drs. C. Adler and I. M. Casanowicz, contains more than one such reference. It is not likely that Dr. Walter Hough's exhaustive monograph on the lamp of the Eskimo was ready for the printer before the articles that precede it. Why should not all these have been issued separately, or at least reserved for the 1897 Report?

To write any comprehensive review of the extraordinarily diverse matter in the three volumes before us would be impossible for a single individual, however unlimited his time. The papers following the Smithsonian Report are representative of the various branches of science, and the general reader will gain from them a fair idea of what is now being done by scientific workers. Most of them have appeared elsewhere, but English-speakers will be glad to have the translations of Dr. L. Königsberger on 'The Investigations of Hermann von Helmholtz on the Fundamental Principles of Mathematics and Mechanics,' Professor A. Cornu on 'Physical phenomena of the upper regions of the atmosphere,' O. Wiener on 'Color photography by means of body colors, and Mechanical color adaptation in nature,' Dr. Heim on 'The biologic relations between plants and ants,' H. Meyer on 'Bows and arrows in Central Brazil,' and J. de Morgan's 'Account of the work of the service of antiquities of Egypt and of the Egyptian Institute during the years 1892, 1893 and 1894.' As an example of work carried out under the auspices of the Smithsonian Institution, we are presented with Dr. J. Walter Fewkes' 'Preliminary account of an expedition to the Pueblo ruins near Winslow, Arizona, in 1896,' which expedition, it may be noted, accomplished its work some weeks after the annual report was transmitted to Congress. Other communications that appear to be published here for the first time are: 'Was primitive man a modern savage?' by Talcott Williams; 'Memorial of Dr. Joseph M. Toner,' by Ainsworth R. Spofford, and 'William Bower Taylor,' by W. J. Rhees. The rest of the articles are reprints, mainly from the Proceedings of the Royal Institution of Great Britain and from SCIENCE.

The more technical papers based on the collections in the U. S. National Museum are contained in Vol. XX., of the Proceedings of the Museum. In pursuance of the excellent policy pursued by the Institution, these have already been issued in pamphlet form, so as not to delay the publication of important scientific novelties. But it is to be wished that this policy could be carried into effect in a more practical manner. Let us take two examples. The volume opens

with an elaborate and (thanks to the Elizabeth Thompson fund) richly illustrated work on the Rocky Mountain locust and its allies, entitled 'Revision of the Orthopteran group Melanoplus (Acridiidae), with special reference to North American forms,' by that eminent entomologist and bibliographer, S. H. Scudder. The work contains numerous new species and new genera. A key to the genera is given, and is said to have been 'issued in advance in the Proceedings of the American Academy;' but from beginning to end no hint is given as to the previous publication of the paper as a whole, and 9 workers out of 10 would be as likely as not to give it the date of the bound volume, which the title-page states to be 1898, but which, one may hazard a guess, was really 1899.* The tenth worker might have received the previously issued separate copy of Mr. Scudder's paper, though it was unknown to the laborious compiler of the section Insecta in the *Zoological Record* for 1897—a somewhat important fact in this connection; or he might chance to see in the table of contents the affixed date, 'December 28, 1897.' Is this date intended for the date of previous publication? If so, a statement to that effect should have been repeated at the beginning or end of the article itself. Even the previously issued separate copies of these articles do not bear the exact date. The paper wrappers give the year (truthfully, let us hope!), but what we have been led to expect from American systematists is at least the month, if not the day or even the hour of publication, printed on the sheet itself. In the second example that we shall take, matters are more complicated. No. 1132 is 'Preliminary diagnoses of new mammals* * * * from the Mexican border * * * ' by Dr. E. A. Mearns. The competition between the describers of species in this class is now so keen that the demand for dates is imperative. The Smithsonian meets the appeal with its wonted generosity. It gives three dates: the date of the bound volume, 1898 [or 1899]; 'Advance sheets, March 5, 1897;' and again, 'January 19, 1898.' What, then, is the date of *Neotoma cumulator*

*At any rate the volume has not yet been received by the British Museum (Natural History), 22 April, 1899.

Mearns? The date of the advance sheets is, in this case, given with the paper itself, and they are described as 'published.' But if so, there can be no meaning in the date 'January 19, 1898.' If, on the other hand, 'January, 19, 1898,' is regarded by the Secretary to the Smithsonian as the date of publication, then the advance sheets must be ruled out of court. What do you mean by 'advance sheets,' anyway? Are they proofs under revision? Are they to be had by the public? Can they substantiate a claim of ten or eleven months' priority? These questions are not rhetorical. We want to know. The ever-green preliminary notice is nuisance enough; but a preliminary notice that ranges vaguely between March, 1897, and February, 1899, ought to be snuffed out by its own absurdity.

To turn from these vexed and vexing questions to the papers themselves—After Dr. Scudder's monograph, which occupies nearly half the volume, the more important are Professor E. Linton's 'Notes on Cestode and Trematode parasites of fishes,' Professor Dean C. Worcester's and Dr. F. S. Bourns' 'Contributions to Philippine Ornithology,' Walter Faxon's 'Observations on the Astacidae in the U. S. National Museum and in the Museum of Comparative Zoology [Cambridge, Mass.], with descriptions of new species,' Professor C. P. Gillette on 'American leaf-hoppers of the subfamily Typhlocybinae,' Professor A. E. Verrill's and Miss K. J. Bush's 'Revision of the deep-water Mollusca of the Atlantic coast of North America, with descriptions of new genera and species. Part I., Bivalvia.' From these and the lesser papers in the volume it is clear that the U. S. National Museum plays an effective part in the advancement, no less than in the diffusion, of knowledge; and the high proportion of contributions from others than those on the staff indicates a total absence of that dog-in-the-manger quality which often finds a congenial home in establishments of this kind.

Indeed, if there is one character more praiseworthy than another in these records of work done it is the spirit of helpfulness and fraternal cooperation that animates the whole. The concentration of the national collections in one group of buildings, the association of the

Museum with an institution of such world-wide scope as the Smithsonian, the proximity of other administrative and scientific departments of the government, all tend to foster this spirit. Nevertheless, its development, as we see from the example of other cities, is not a necessary consequence; it needs cultivation. In Washington its growth is due less to favoring circumstances than to the high character and ideals of the men connected with the Smithsonian Institution, and notably of recent years to the charming personality and unwearying efforts of the late Assistant Secretary. A remarkable instance of this appears in the list of the scientific and administrative staff, which comprise among the Curators or Assistant Curators no less than 28 described as 'Honorary, and serving without salary.' The work done by these unpaid curators is no mere amusement; they take their share in the drudgery of registration, labelling and cleaning. It is true that the majority of them receive pay from the government in other capacities; but this emphasizes the point, for rivalry rather than cooperation between the various departments is the rule in most other countries. The gain, of course, is not wholly on the side of the Museum.

In harmony with these principles of mutual aid, the Museum differs from many national museums in its custom of sending out large quantities of material. Partly this is in connection with local exhibitions, and this branch of the Museum's activity may be compared to that of the Loan Section of the British Science and Art Department. Further, specimens are lent to scientific workers freely and in large quantities. Presumably this applies, not to specimens of historic interest, but to material in the reserve collection. No doubt some damage is done and some specimens may be lost in consequence of these operations. For all that, the Museum is a gainer, on the one hand by the awakening of national interest and the increased number of its correspondents, on the other through the elaboration of its material by specialists in all parts of the world.

Apropos of correspondents, those of the Smithsonian and the Museum are perhaps numerous enough already. Every citizen of the United States seems to be as tenacious of his right to

question the officers on any subject under the sun as he is of his right to shake hands with the President. The list of specimens sent to the Museum for identification during the year fills 24 columns. About 10,000 letters seem to have been received and replied to. The conchologists alone had to identify over 3,000 species and to write over 1,000 pages of correspondence. Defensive measures have become necessary. *Circular 47*, U. S. National Museum, stipulates that the material must be sent free of expense to the Museum, unless otherwise agreed upon, and that the localities from which the specimens were obtained must be given. The Museum reserves the right to retain, except under special arrangement, specimens needed to complete the national collection.

There are many other points in these Reports one would like to discuss did one not feel the information to be a little out of date. Attention may, however, be directed to Dr. J. M. Flint's account of methods for the public exhibition of microscopic objects (*Rep. U. S. N. M.*, pp. 96, 97, pls. i.-iv.). There are two forms of apparatus; in both an ordinary microscope is employed, but in one the objects are fixed on a rotating disc, while in the other ordinary glass slips are attached by brass clips to an endless linen band passing over rollers. "Microscopes copied from the original here described have been in use for several years, and no irremediable difficulties have been found in the way of their perfectly successful operation." An apparatus of this kind has been in use at the Hamburg Natural History Museum for some years; but few, if any, other museums have followed this example. Perhaps Dr. Flint's account may induce them to adopt this method of overcoming the difficulty of exhibiting very minute objects. The foregoing is only one instance of the improvements in museum technique that are constantly being introduced by the energetic officers of the U. S. National Museum. It is the detailed account of such matters that makes the Report of permanent value to other museum-curators, while it evinces the hearty interest taken in their work by all members of the staff.

F. A. BATHER.

NATURAL HISTORY MUSEUM,
LONDON, S. W.

Introductory Logic. By JAMES EDWIN CREIGHTON. The Macmillan Company.

The aims of this book, as indicated in the preface, are three. It is intended for an elementary college text-book; it is founded on a belief in the value of the traditional 'formal' logic, and hence on a desire to conserve, just so far as may be, the forms and exercises of that logic; and the author hopes, before he has done, to have presented likewise a genuinely modern theory of thought. The first purpose, of course, must be kept in mind in judging ultimately both the omissions of the work and all the admissions into it that occur in the way of obvious reflection and simple enlarging comment. The aim of saving the greater body of the old logical teachings, is one which—provided only writer or teacher knows how to breathe again into the material some of the ancient Socratic living practicality and fresh keenness—the majority among instructors of raw classes would still approve of. Their most critical query, therefore, touching this phase of Professor Creighton's work, would be: How far is this endeavor reconciled with the author's third chief aim, that of satisfying also, in his expositions, the requirements of modern scientific truth and orderly completeness? And here, in this attempt of combining and correlating, in a purely elementary treatise, the methods, content and advantages both of the old logic and a newer one, is plainly intended to lie the special feature of our book; as here, indeed, would appear to be afforded, to any writer, his most distinct opportunity for achieving a marked success, if not even his most valid reason for writing at all. For here—it would seem at least—is the largest room for competition with a number of most excellent text-books already outstanding. Thus, on the one side, Minto's *Logic* is an almost ideally satisfactory beginner's manual, save in the important circumstance that it hardly more than informs the student of the existence of the modern profounder *theory* of thought; while, on the other hand, a work like—say even Bosanquet's *Essentials of Logic*, with all its incomplete expression and the tension in its style—presents the broad outlines of the organic view of thought with an admirable philosophic ability, but too far ignores, to ful-

fill entirely the uses of an ordinary introduction, the traditional staple of logic. These simple analyses and operations, as a matter of fact, besides retaining still a certain real point and meaning, would deserve some special consideration if only from the circumstance that, the new branch of induction aside, they are substantially what, in the popular notion and even in the common run of handbooks, will be always confronting the student *as logic, sole and simple*. Professor Creighton commendably would recognize these facts more completely than Dr. Bosanquet has cared to do.

The first two chapters of his book Professor Creighton devotes to an Introduction. The definition of logic, with which he sets out, suffice it to say, is thoroughly modern in spirit. So, too, his differentiation of the function and materials of logic from those of psychology is carried out in a modern, and, moreover, a soundly practical way. In both these connections it would, indeed, have been instructive to have been given some moderately searching review of the effect of different conceptions of the real nature of thought; but this, doubtless, was a topic felt to lie outside the scope of the book. On the venerable theme whether or not logic is an art as well as a science, the author expresses himself thus: The analyses of logic are capable of a practical application, but not to the extent of constituting an art. Thinking is too flexible to enable us, on the basis of our theoretical knowledge, to lay down, as we can in photography or even in medicine, rules for its definite guidance. It is possible to prescribe only the general conditions that must be observed in reasoning correctly.—The question here of our agreement or otherwise will largely be a verbal one as to how an art is to be defined. Professor Creighton himself speaks of the Aristotelian logic, in the ordinary representation, as perhaps more properly described as an art. Still, it may be suspected whether Professor Creighton's general denial of a strict art-character to logic does not hinder him, in his subsequent exposition of the old syllogistic logic (his *exposition*, but *not* the admirable 'exercises' he has appended at the close of the volume), from quite giving due emphasis to those exercises in So-

cratic 'dialectic' and 'induction,' in interpretation, definition and the like, wherein, rather than in the operation of mere abstract formulae—A's and E's, S's and M's, Baroko's and I kardo's—lies the best discipline of 'formal' logic. But even more is it to be feared whether the conventional presentation of the old logic which, as we shall see, Professor Creighton in the most part follows—whether this presentation, either in fulness or in order and method, can meet the requirements of science in the rigorous modern sense, and must not rather seek its sole justification in a paramount simple aesthetic than a strictly scientific interest and character.

The second chapter of the Introduction very appropriately a historical sketch. A crying need in the maze of contemporary logic doctrine is a simple but accurate and all-around elucidation for the student—if only for the sake of enabling him to approach the literature intelligently—of the various connections and distinctions of logical standpoints and so-called departments; and of all methods, moreover, of effecting this end, the historical can hardly be denied to be the easiest and most enlightening. Professor Creighton undertakes such a historical explanation with reference to Deduction, Induction and the 'New' logic; and his sketch is concise and bright—so far as it goes at all. Thus his account of the origin, development and respective functions historically of the Aristotelian and the inductive logics is animated, to the point, and for the most part very satisfactory. When, however, we come to the logic out of whose point of view his own treatment is to be determined, he merely *says* that it has arisen under the influence of Hegel, but how it has done so, and what Hegel's logic itself is like, or what are its antecedents back to Kant or, perchance, to Plato—all this is utterly passed over. Assuredly this failure of the author's, after he has devoted ten pages to the origins and evolution of a logic (the syllogistic) which he does *not* accept, at least as final, to provide some account of the historical beginnings and course of growth of that conception which he *does* accept as adequate, is to be set down as a defect not remedied even by the systematic exposition of this truer view which we

get in Part III. of our book. How very difficult it is to put simply, and yet in orderly truth, the history of that fruitful notion of thought and logic which Professor Creighton adopts, everyone must appreciate who has endeavored to teach it; but then, in the degree that this history is essential for our students, its difficulty, as already remarked, is just a writer's best opportunity, and his best justification for adding one more book to the many.

A more thorough preliminary working out of the development from the old to a new logic would have been not only helpful to the student, but of service to the author himself. For, in his desire to accord to the old logic that due recognition which constitutes one of his prime objects, he feels obliged, apparently, in the exposition of 'Syllogism,' which makes up Part I. of our book, to reproduce in the main also the old conventional, half-false order of topics—Terms, Propositions, Immediate Inference, Syllogism, Fallacies—and the old narrow, distorted theoretical descriptions, with a fuller truth of relationships pointed out only incidentally or forgotten altogether. In Chapter I. of this same part, some general precautions are, indeed, put forward; but the author himself does not live up to them; how much less will the thoughtless student! As an extreme illustration of failure of fidelity to the interests of the higher standpoint and a reversion, for the time-being, to olden easy-going, slipshod methods, may be cited the treatment of Terms. We are abruptly informed (p. 46)—"*wie aus der Pistole*"—that "the first divisions which we have to notice is that into Singular or Individual, General and Collective terms." These being defined in the familiar way, we are given the further divisions into abstract and concrete, positive and negative, absolute and relative; which distinctions, it should be said, particularly that of abstract and concrete, are handled very well from the point of view of the old-time 'art of logic.' What, though, of 'new' theory of thought is there in this (p. 52)?—"Positive (terms) express the existence * * *. A Negative term indicates the absence * * *. Words which are positive in form, are, however, often negative in meaning * * *." Or what in this (p. 55)?—"The nature of everything is

largely [*sic*] determined by the nature of the things with which it stands in relation * * *. It is, however, possible to make a distinction between words which are the names of things comparatively [*sic*] independent and * * *." It is but in keeping to find this chapter *ending* with the subject of extension and intension of terms, i. e., with that which ought to form the *beginning* of the treatment of such distinctions as individual and general, collective and material, etc. Now, to be sure, all this can be no result of a sheer ignorance of the spirit and demands of modern logic. Part III. sufficiently shows the contrary; and even in this same first Part we are given a chapter such as that on hypothetical and disjunctive arguments, one that is fertilized throughout by organic reflections, and, in consequence, is the freshest, most interesting and best of this entire section of the book. Or perhaps it would be juster to say that Professor Creighton knows quite generally how to be interesting, as also to be neat and concise, and, in most matters, pedagogically tactful. His only difficulty is an unresolved conflict of ideals—of the elementary practical interest of the old logic, with the theoretic one of exhibiting the doctrines of this logic under a wider scientific point of view. In this conflict, now the one end and now the other, is lost sight of; but herewith, of course, the author's great purpose of satisfying the requirements of both old and new logic goes just so far by the board.

The faults of Part I., however, are in sharp contrast with the merits of Part II. The latter is, by all odds, the best-done portion of the book. Here, too, perhaps, there might still be room for a completer working-out of systematic implications and relations; and there remains, after all the author's great deductions, too orthodox an assent to the 'Five Methods' of Mill; nevertheless, Professor Creighton here plants himself, everything considered, on modern ground, and in the attitude of live *thought*, with the result of giving us one of the very best introductory treatments of Induction that we possess. Aside from the difficulty of correlation that must arise for the student from his not having previously been given a genuine theory of thought deductively regarded, but only the mechanics of scholastic syllogistic—the

true relation of induction to deduction is both made clear in an introductory chapter and soundly adhered to afterwards. These are throughout described, not as two distinct things, but as distinguished phases of one and the same total activity of thought; deduction throwing an explicit emphasis upon the particularizing and synthetic aspect, while induction emphasizes the analytic and generalizing sides. The nature and distinction, likewise, of observation and explanation are very adequately set forth in the introductory chapter. Observation, the author earnestly enforces, is not a mere staring at facts: "To observe well it is necessary to be more or less definitely conscious of what one is looking for; etc., etc." Though he reserves the express assertion of the influence of hypothesis on even preliminary observation to a later chapter, it is implied throughout. Naturally, therefore, the difference, too, between observation and explanation is regarded not as absolute, but as largely a mere convenient one—of the final articulate bringing to bear of reason on experience, in contradistinction from an earlier half-groping stage of the same thing. So, likewise, of course, the goal of induction is conceived to lie, not in a mere empirical, passive gleaning of causal connections and generalities, but in the completion of that explanation we have just been speaking of—the active expansion of the living system of self-conscious human reason for and by the inclusion of the facts under investigation.

After the introductory chapter come three others on Methods of Observation—the first dealing with Enumeration and Statistics, the two others with the Determination of Causal Relations—under which head is given an exposition of the Methods of Mill. All this is well done, though, as already suggested, the simple acceptance of Mill's 'methods' as undisputed descriptions of the actual procedure of science is open to grave dissent. However, there is no failure to point out the drawbacks of the several methods separately; nor is the author in any sense guilty of treating them as being more than what at best they are—mere methods of *observing*, that is to say, methods not for the final solution of scientific problems, but, as Welton has aptly put it, methods merely for suggesting *hypotheses*. The two chapters on Methods

of Explanation—the first on Analogy and the second on The Use of Hypotheses—as well as the concluding chapter on Fallacies of Inductive Reasoning, call for no comment. They are very good pieces of work.

Part III. deals with The Nature of Thought. Starting from the view of thought as an organism, and of knowledge as a passage not from the inward and known to the outside and unknown, but always from a previous part of knowledge to one of greater perfection, the author goes on to point out that thought as knowledge unfold or develop in accordance with the general laws of evolution; that this development is a progressive process both of differentiation and integration; that the different intellectual operations, as conception, judgment and inference, or induction and deduction, are not separate processes, but stages in one and the same activity; and that the nature of this activity is essentially discoverable in its simplest and most elementary form, the judgment—for the concept is not the original element, out of which judgment is afterwards compounded, but is only the series of judgments that have already been made and that serve as the starting-point for new judgments. Judgment, accordingly, is the main theme of this present subdivision of our study.

The chief characteristics of judgment as the type of all thought and knowledge are: (1) its universality (claim of truth for everybody); (2) its necessity (not a mere psychological compulsion, but one arising from the dependence of judgment on *grounds*); (3) that it is always both synthetic and analytic; (4) that it is constructive of a *system* of knowledge. In this connection, however, require to be considered also the so-called 'Three Laws of Thought.' As very commonly put, these pretended supreme 'axioms' of judgment are altogether false. Rightly formulated, though, they are real laws of thought, in the sense of being implied in and descriptive of the thought-process as just set forth. (The topic of laws of thought in general, or of Categories, Professor Creighton does not enter upon.) The development of judgment, from a merely *felt* to a *conscious* necessity, gives rise to types of judgment. The succession of these is traced on broadly Hegelian lines, from quality

through quantity (enumeration and measure) and causal connection (stages in this latter conception being pointed out), to the completed form of individuality (which is that of unified system).

The chapter on The Nature of Inference requires no special comment, except that the solution offered of the old paradox: How can the mind pass from the known to the unknown?—to the effect that there is no such passage, there being “always a certain amount of identity between the two ends of the process” [p. 326]—is hardly searching. Should not questions of this sort, if taken hold of at all, be handled with a certain thoroughness, even where it is inexpert novices that one has to reckon for? The concluding chapter, likewise, on Rational and Empirical Theories, calls for no discussion, its spirit being manifest from what has been already related, and its upshot, in the rejection of either attitude in abstraction, sound, notwithstanding that the rationalism described is rather that of Descartes than the profounder doctrine of Kant.

Of this Part as a whole, this much only need be said. So far as it really proceeds, it is excellent and, doubtless, gives the entire book a value immeasurably beyond that of the dry, shallow, old-fashioned manual. And yet a questioning does arise, just how far the practically total avoidance of direct issue with the more fundamental difficulties concerning thought—the refusal to dip even lightly into the deeper waters of philosophy—is an advantage even for beginners, beginners of the sort who are ready to read such a book as this at all? For may it not be doubted if a bright student can fail—and is it not to be hoped that he shall not fail—to be perplexed by a groping perception of problems, a mere definite pointing out of which, or a mere hint towards whose solution, would have been of the greatest help to him, but which here are quite ignored? Surely our fear should be, not of bringing our pupils, when need is, into the labyrinths of metaphysic, but of ourselves not proving clear-sighted guides therein. However, in this point it may be that our judgments must turn on individual notions of how completely logic can and ought to be cut off from metaphysics.

Evidently in this work Professor Creighton has not given us the ‘definitive’ text-book—if there be any sense in the shallow favorite phrase. His book does not closely approximate its design. What he has produced is this, a book with a good many good things in it. These require a stricter organization; in parts, some supplementation; in other parts (perhaps), a pushing deeper back into philosophy; and, in one section, a considerable correcting. Yet with all these drawbacks—granted a teacher capable of coping with them—Professor Creighton’s book is not unsuited, as an introduction, to become a very useful one; rather it undoubtedly *is*, as pointing in a wholly desirable direction, one of the very best on the market.

GEORGE REBEC.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *Journal of Geology*, February–March, 1899. The first paper is by Henry S. Washington, and is the third installment of the series relating to ‘The Petrographical Province of Essex County, Mass.,’ pp. 105–122. Dr. Washington treats of the rocks occurring in dikes, viz: Aplite, quartz-syenite-porphry, paisanite, sölvbergite and tinguait. The series is to be continued. B. Shimek, ‘The Distribution of Loess Fossils,’ pp. 122–141. The author emphasizes certain important points in the character and distribution of the fossil shells found in the loess, basing his conclusions on facts observed in connection with existing land shells. His observations confirm the Æolian origin of the Western loess. H. W. Turner, ‘Granitic Rocks of the Sierra Nevada,’ pp. 141–168. This is an important addition to our knowledge of the general petrography of the granitoid rocks of the Sierras. Types embracing true granites, grano-diorites, quartz-monzonites, soda-aplites, quartz-diorite-aplites and pegmatites we described with many analysis. Under the studies for students the development and geological relations of the mammalia are outlined by E. C. Case. Editorials and a valuable summary of ‘Current Pre-Cambrian Literature,’ by C. K. Leith, close the number. The latter contributions are particularly to be commended,

as they afford excellent summaries and temperate and judicial comments.

WE are glad to note that owing to its increasing circulation the publishers of *Science Abstracts* (Spon & Chamberlain, New York) have been able to make a reduction in the price. The journal, issued monthly under the direction of the Institution of Electrical Engineers and the Physical Society of London, is performing a very important service for the advancement of science. The first volume contained 1,423 abstracts and thus gives a full survey of the progress of physics and electrical engineering. The advantages both pure and applied science gain by cooperation in the publication of this journal are evident on almost every page.

SOCIETIES AND ACADEMIES.

IN response to a circular sent out to physicists by a committee representing seven institutions, a meeting was held on Saturday, May 20th, at 10:30 a. m., at Columbia University, New York, for the purpose of organizing a Physical Society. Thirty-eight persons were present, representing seventeen institutions, as follows: Wesleyan University, 2; New York, 2; Yale, 3; Cornell, 5; Columbia, 7; Pennsylvania, 2; Bryn Mawr, 2; Vassar, 2; Princeton, 2; Amherst, 1; Mt. Holyoke, 2; Smith, 1; Harvard, 2; Vermont, 1; Swarthmore, 2; Clark, 1; U. S. Weather Bureau, 1. Letters had been received by the committee from many physicists in all parts of the country, expressing approval of the organization and a willingness to join.

Professor Pupin welcomed the physicists present on behalf of Columbia University, and introduced Professor Cooley, of Vassar, the senior member present, as Chairman of the meeting. Professor Webster was elected Secretary, and addressed the meeting in explanation of the purpose of the call. Reports of communications received by members of the committee were made by the Secretary and by Professors Magie, Nichols and Pupin. On motion of Professor Rosa, it was voted that a Physical Society be organized. On motion of Professor Magie, it was voted that a committee be appointed to draft a constitution for the Society. On motion of Professor Magie, it was voted that the meet-

ings be held in New York, except in special cases. An amendment offered by Professor Nichols was adopted, to the effect that the meeting express the willingness of the Society to establish local sub-sections meeting in other cities when a demand shall arise. After a rather lengthy discussion, an amendment proposed by Professor Pupin was adopted, to the effect that the meeting express the sentiment of the Society to cultivate the closest relations with Section B of the American Association for the Advancement of Science, and to contribute by everything in its power to the success of the Association. Upon motion of Professor Magie, it was voted that a bulletin be published by the Society. Professors Webster, Nichols, Magie, Peirce, Hallock and Pupin were elected as the committee to draft a constitution. The meeting adjourned at 12:30 and partook of lunch kindly provided by representatives of Columbia University.

The session was resumed at 2:20 p. m., and the constitution submitted by the committee was adopted. All the above notes were therein embodied. A list of nominations for officers was reported by the same committee, and the following were unanimously elected: President, Professor H. A. Rowland, of Johns Hopkins; Vice-President, Professor A. A. Michelson, of Chicago; Secretary, Professor Ernest Merritt, of Cornell; Treasurer, Professor Wm. Hallock, of Columbia. Nominations were then made from the floor for members of the Council, who, with the officers, are to have the general management of the Society, and the following were elected: Professors A. G. Webster, of Clark; J. S. Ames, of Johns Hopkins; H. S. Carhart, of Michigan; B. O. Peirce, of Harvard; W. F. Magie, of Princeton; E. L. Nichols, of Cornell; M. I. Pupin, of Columbia.

It was voted that the election of new members be made by the Council; that the annual fee be five dollars; that there be no initiation fee, and that four meetings be held annually.

The constitution provides that the name of the Society shall be the American Physical Society, and that its object shall be the advancement and diffusion of the knowledge of physics. A circular will soon be issued containing the text of the complete constitution, which will be

sent to physicists generally, and provision will be made that those voting upon it by mail shall be received as original members of the Society. The first regular meeting will be held in October. Already about a hundred members are assured, and it is hoped that the Society may eventually contain all leading American physicists and take a prominent place among our scientific societies.

A. G. WEBSTER,
Secretary pro tem.

THE BIOLOGICAL SOCIETY OF WASHINGTON.

THE 804th regular meeting was held March 11th. The program consisted of an illustrated lecture on the general physiographical and biological features of Puerto Rico by Dr. R. T. Hill, of the U. S. Geological Survey. The mountain and drainage systems were explained and classified, and the relations of the various geological formations and the resulting soils to the flora and agricultural resources of the island were pointed out.

The lecture was supplemented by informal accounts from Dr. B. W. Evermann, of the U. S. Fish Commission, and Mr. A. B. Baker, of the Zoological Park, who had recently returned from Puerto Rico. Dr. Evermann stated that the coasts are almost everywhere abrupt and rocky, and that the water is generally agitated by a powerful surf. The result of these conditions is that only those types could survive which were adapted for life in deep water or which were fitted by habits and structure to secure protection among the rocks. This applies not only to the fishes, but to the molluscs, crustacea, algæ and other groups, all classes of aquatic organisms having received the attention of the expedition. The fresh-water fish fauna is not extensive and has been derived independently from marine groups, having no connection with the fresh-water forms of the continent. Dr. Evermann also explained the methods of the native fisherman and exhibited examples of traps and decoys for fishes and turtles.

Mr. Baker noticed some additional points regarding the geography and physiography of the island and the almost complete destruction of the forests, which has had a disastrous effect

upon the fauna, having more less completely exterminated some species and caused profound changes in the habits of others.

At the 305th regular meeting, March 25th, Dr. T. S. Palmer traced the history of the introduction of the English sparrow into the United States and its subsequent gradual distribution throughout temperate North America.

The case of the mongoose in Jamaica, Puerto Rico and Hawaii was also considered, together with accounts of other accidental or intentional importations of mammals or birds, and the general conclusion was drawn that once removed from the natural conditions and checks of its original habitat it is impossible to know in advance of the experiment what the utility or injury of any given species will be, and hence such experiments should be undertaken with the greatest caution. The speaker considered the introduction of game birds attended with less danger on account of the fact that they would more easily be kept under control by human agency.

Mr. M. B. Waite exhibited specimens illustrating 'The Effects of the Recent Severe Cold on Vegetation,' and described the processes attending the freezing of plant cells, explaining that sudden thawing caused death in many instances because the protoplasm of the cells was unable to reabsorb the water lost in freezing.

The extent of recent injuries to fruit trees and ornamental and native plants was then touched upon and subsequently discussed by several members.

Mr. F. A. Lucas then read a paper on the 'Mental Traits of the Fur Seal,' saying that it had a practical bearing on the question as to whether or not the fur seal was likely to change its habits owing to the presence of man on the islands where it bred. The behavior of the seals on the drives and killing grounds was described as showing the low grade of the animal's intellect and its inability to think for itself. The female seals were said to take little interest in their offspring and to show no affection, while the sight and smell of blood seemed to produce no effect on the animals. The conclusion reached was that the fur seal is a creature of instinct and not guided to any extent by reason; that its habits, having been formed by

the slow process of natural selection, were not likely to be changed. The general impression that the seal is a very intelligent animal was thought to be partly explainable by the fact that its non migratory relatives, such as the sea lion and the hair seal, are in reality much more adaptable, not being possessed of the powerful and unvarying instincts of the fur seal.

O. F. COOK,
Secretary.

GEOLOGICAL CONFERENCE AND STUDENTS' CLUB
OF HARVARD UNIVERSITY.

Students' Geological Club, February 14, 1899. Mr. A. W. G. Wilson gave a 'Demonstration of Mineral Determination by Volatile Iodide Coatings.' After presenting a brief *résumé* of Dr. Haanel's paper 'On the Application of Hydriodic Acid as a Blowpipe Reagent,' he demonstrated the use of plaster of paris tablets as supports, and of hydriodic acid as a reagent for the determination of a number of the common and some of the rarer elements.

Geological Conference, February 21, 1899. Mr. J. E. Woodman spoke on 'Notes on the Glacial Geology of Nova Scotia.' The Province is divided into two parts by fairly sharp boundaries. In the south is the lake region, characterized by till, without distinct form, or in the form of moraines and occasional drumlins, and a little stratified drift. In the north, lakes are largely absent, and there is a considerable amount of stratified drift, with few morainal deposits. In the center, near the northern edge of the lake region, drumlins of a very elongate form are abundant.

Throughout the country the direction of ice-movement was controlled by pre-Pleistocene topography to an extent seldom seen in New England. Thus, in Cornwallis and Annapolis valleys the ice followed the same lines as present drainage; in the center of the Province it ran southward, and along the north shore east of Pictou it ran eastward. The short distance of carriage of much of the drift is noticeable. Changes in the character of the drift follow quite closely those of the larger features of bed-rock geology.

The center and eastern part of the Province

shows little stratified drift. The northwestern portion shows a considerable amount, chiefly in the form of eskers and kame-terraces. Many fine eskers can be followed on the road from Yarmouth to Windsor, but east of there few occur. The absence of coarse material in the central part of the peninsula is very noticeable. Few surface boulders are seen along the railroad line after leaving the lake and morainic country at Windsor Junction, until well on toward the Strait of Canso, where a few morainic accumulations were noted. All along the north coast the drumlins are indistinct in outline, being, with very few exceptions, mere drumlinoid hills. In the Strait, ice-motion changed from east to south along the now sunken valley.

In Cape Breton the obedience of ice-motion to topography is still more marked. The mass appears to have moved, in the interior, from the low region of the Bras d'Or lakes northward along the valleys of rivers which now flow south. This motion did not continue far, and the higher parts of the islands are all unglaciated. On the west and northwest coast the ice affected only the bordering Carboniferous lowland, penetrated a very short distance up the wider valleys, and left the central peninsula, on granite and schist, untouched.

J. M. BOUTWELL,
Recording Secretary.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

At the meeting of the Academy of Science of St. Louis, on the evening of May 15, 1899, thirty persons present, the Secretary presented, by title, a paper by Professor F. E. Nipher, on 'Temperatures of Gaseous Nebulæ.'

Professor E. M. Shepard exhibited an interesting series of lantern slides and ethnological specimens procured by him during a recent extended trip through the islands of the South Pacific, especially New Zealand, Fiji and Samoa, illustrating the natural history and ethnology of those islands.

Two persons were proposed for active membership in the Academy.

WILLIAM TRELEASE,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

THE TELEPATHIC QUESTION.

TO THE EDITOR OF SCIENCE: When a scientific discussion degenerates into protest and imputation of motive it is probably time for the discussion to stop. But I wish to state, in self-defence, that I do not 'seek to leave upon the reader's mind' the two impressions to which Professor James refers. I do not say that Lehmann first considered whispering; I say that he was the first *thoroughly to investigate* it. There is a difference. I do not imply that Lehmann introduced number-habits; I say that the next step in advance beyond him is an exhaustive study of number habits. Again, there is a difference.

E. B. TITCHENER.

CURRENT NOTES ON METEOROLOGY.

CLIMATIC CHANGES ON THE PACIFIC COAST.

In the *National Geographic Magazine* for May the question of climatic changes on the Pacific coast is discussed by J. B. Leiberg, under the title: '*Is Climatic Aridity impending on the Pacific Slope? The Testimony of the Forest.*' The most important results of the study are as follows: The arid, non-forested plains of eastern Oregon yield silicified remains of arborescent vegetation nearly or quite identical with existing species on adjacent areas, thus proving the presence of forest growth on these timberless lands at no very remote period. On the semi-arid tracts the forest, although consisting of species capable of enduring dry climatic conditions, show everywhere a persistent and gradual dwindling in extent and density. In the subhumid forest there is a slow and apparently ineffectual adaptative evolution of smaller forms of the various species to replace the larger ones which require more moisture for their growth. In the humid forest the same phenomena are found. So far as the evidence derived from a study of the forest conditions is concerned, there seems to be a fairly well defined change of climate in progress on our Pacific coast, from a more humid to a less humid.

In the same number of the *National Geographic Magazine*, Ganett, in a paper entitled '*The Redwood Forest of the Pacific Coast*,' states that

"everything appears to indicate that for some reason, probably a progressive drying of the climate, the present environment is not favorable to the growth of redwood, and that with the clearing away of the present forests the end of the species as a source of lumber will be at hand."

WAVE CLOUDS.

THE formation of waves between different strata of the atmosphere was carefully studied and described by von Helmholtz. These waves become visible only when clouds are formed in them at those points where condensation takes place, but undoubtedly invisible waves occur very commonly in our atmosphere. The appearance of clouds in parallel lines across the sky is an indication of the presence of atmospheric waves. In the February number of the *Monthly Weather Review*, A. J. Henry, of the U. S. Weather Bureau at Washington, presents five excellent views, reproduced from photographs, of alto-cumulus cloud rolls, observed at on November 23, 1898, and on January 27, 1899. The views of November 23d are especially interesting as showing the gradual dissolution of the clouds.

METEOROLOGICAL WORK IN ALASKA.

THE Central Station of the Alaskan Section of the Climate and Crop Service of the Weather Bureau has been transferred from Sitka to Eagle, on the Yukon, near the British line. The Chief of the Weather Bureau hopes, by this change, to facilitate the establishment of meteorological stations in the region of the upper Yukon, where, owing to poor facilities for communication, it was found impossible to establish such stations when the headquarters of the Service were at Sitka.

RECENT PUBLICATIONS.

Measurement of Precipitation. C. F. MARVIN, U. S. Department of Agriculture, Weather Bureau. Circular E, Instrument Division. 8vo. Washington, D. C., 1899. Pp. 28.

A pamphlet of instruction for the measurement and registration of precipitation by means of the standard instruments of the Weather Bureau.

Ninth Annual Report of the Board of Directors of the New Jersey Weather Service, 1898. E. W.

MCGANN. 8vo. Trenton, N. J., 1899. Pp. 205.

This Report contains a relief map of New Jersey, prepared by the Geological Survey of the State, with the note: "The influence of the diversified topography of New Jersey upon its climate is apparent by comparing this relief map with the temperature and rainfall charts which follow." This plan of publishing topographic maps of the different States in the Annual Reports of the Weather Services is an excellent one, and should be generally adopted.

Rivers of Oregon, Washington, Idaho and Western Montana. B. S. PAGUE. River Bulletin No. I., 1899, U. S. Department of Agriculture, Weather Bureau. Portland Ore., 1899.

This valuable Bulletin, the first of its series, concerns the precipitation over the Pacific Northwest and the possibility of high water from the melting snow in the mountains. It contains a general forecast of the probable height of the Columbia River in May and June, as dependent upon the temperature conditions and the resulting more or less rapid melting of the snow on the mountains.

Monthly Rainfall Chart for Fifty Years at San Francisco. Compiled by HERMAN SCHUSSLER, C. E. Published by the Central Pacific Railroad Company.

A graphic representation of the monthly rainfalls for each year during the past fifty years.

R. DEC. WARD.

HARVARD UNIVERSITY.

A BRYOLOGICAL MEMORIAL MEETING.

COLUMBUS was the home for many years of William S. Sullivant and Leo Lesquereux, two names which will awaken love and reverence from all students of North American mosses and hepatics. It is twenty-six years since Sullivant died, and this last quarter of a century has seen a marked extension of the limits of bryological study and a large increase in the number of students. It seems a fitting time and place to take a survey of the field, review the past and make plans for the future. Hence it is proposed to make the coming meeting of the American Association for the Advancement of Science, which is to be held at Columbus, the occasion for a Memorial Day in honor of the

Nestors of American Bryology and to call on all botanists and scientific magazines to help to make the occasion a memorable success. It is proposed to present a series of papers, illustrated by photographs, specimens and microscopical slides, books and pamphlets under the following topics:

Historical papers and collections showing the bryological work of Hedwig, Palisot de Beauvois, Michaux, Muhlenberg, Bridel, Torrey, Drummond, Hooker and Wilson, Greville, Sullivant and Lesquereux, James and Watson, Austin, Ravenel, Wolle, Eaton, Faxon and Müller; supplementing these there will be shown collections of specimens, macroscopic and microscopic, illustrating the monographic work of recent American students.

If foreign students who have worked on North America bryophytes can be persuaded to cooperate with us the following will be asked to contribute: Bescherelle, Brotherus, Cardot, Dixon, Kindberg, Mitten, Pearson, Roll, Stephani and Warnstorf.

An effort will be made to secure the loan of type specimens and illustrations from the following sources: The Academy of Natural Sciences of Philadelphia, Academy of Sciences of New York, Columbia University, The National Museum, The Ohio State University, The University of Wisconsin and Yale University, as well as from private collections. It is also intended to exhibit any portraits, autograph letters and type specimens and drawings of special interest, which may be loaned for the occasion, as well as presentation copies of books and pamphlets.

The following committee of organization will gladly answer questions and give assistance to those who wish to contribute: Professor Charles R. Barnes, University of Chicago; Mrs. N. L. Britton, New York Botanical Gardens; Professor W. A. Kellerman, Ohio State University; Dr. George G. Kennedy, Readville, Mass.; Professor L. M. Underwood, Columbia University.

SCIENTIFIC NOTES AND NEWS.

THE Royal Institution of Great Britain, in commemoration of its centenary, has elected a number of honorary members, including Professors S. P. Langley, Carl Barus, A. A. Michel-

son, R. H. Thurston, J. S. Ames and George F. Barker, and President W. L. Wilson.

THE American delegates to the Congress of Tuberculosis now meeting at Berlin are Dr. Boyd, of the Navy; Dr. Vaughan, of the Marine Hospital Service; Dr. De Schweinitz, of Department of Agriculture; Dr Stiles, scientific attaché to the embassy at Berlin.

MR. FRANK A. FLOWER, Chief Statistician of the State of Wisconsin, has been appointed Chief of the Agricultural Division of the Census.

OXFORD University has conferred the honorary degree of M.A. upon Mr. Roland Trimen, F.R.S., formerly Curator of the South African Museum, Cape Town, and late President of the Entomological Society of London.

LORD JAMES, of Hereford, has been elected chairman of the governing body of the Imperial Institute, London, in the room of the late Lord Herschel.

PROFESSOR GEORGE F. BARKER, of the University of Pennsylvania, and Professor Carl Barus, of Brown University, are among the American delegates attending the Jubilee of Sir George Stokes, of Cambridge.

PRESIDENT WILLIAM L. WILSON, of Washington and Lee University, has been chosen by the Regents of the Smithsonian Institution to represent them at the approaching celebration of the centennial of the Royal Institution of Great Britain.

THE St. Petersburg Geographical Society has awarded its great gold medal to Dr. G. Radde, Director of the Caucasian Museum at Tiflis.

MAJOR ROSS, who has recently been appointed lecturer at the newly established school of tropical diseases at University College, Liverpool, has given a lecture before the Biological Society of that city on the relations of the malarial parasite to the mosquito, to which his own researches have been such an important contribution.

THE death is announced of Sir Frederick McCoy, F.R.S., professor of natural sciences at Melbourne University. We learn from the *London Times* that he was born in Dublin in 1823 and that he was educated for the medical profession at Dublin and Cambridge Universities, but early devoted himself to natural

science. Sir R. Griffith invited him to make the paleontological investigations for the Geological map of Ireland for the boundary survey, the results of which he published in 1844. Afterwards he joined the Imperial Geological Survey of Ireland, and Sir R. Peel's government appointed him professor of geology in the Queen's University in 1850. Professor McCoy undertook, in conjunction with Professor Sedgwick, a large work on paleozoic rocks and fossils based on the Woodwardian collection at Cambridge. In 1854 he was appointed the first professor of natural science in Melbourne University, and held the chair till his death. His services to Victoria were considerable, notably in regard to the Geological Survey of the colony, as a member of various commissions, and as the founder of the Melbourne National Museum. In 1880 he was elected F.R.S., and was one of the first to receive the honorary degree D.Sc. from Cambridge. In 1886 he was made a C.M.G., and in 1891 he was promoted to be K.C.M.G. Sir F. McCoy also received the Order of the Crown of Italy from King Victor Emanuel, the Emperor of Austria's great gold medal for arts and sciences, the Murchison medal of the Geological Society of London, and many similar distinctions.

DR. LUDWIG STRÜMPPELL, professor of philosophy and pedagogy at Leipzig, has died at the age of 87 years. He was an eminent representative of the Herbartian School.

MR. H. B. HEWETSON, an eminent English oculist, has died at the age of 49 years. He was the author of numerous scientific contributions, being a member of the Zoological, Linnæan and Geographical Societies and a member of the Ornithologists' Union.

DR. THEODOR VON HESSLING, formerly professor of anatomy in the University of Munich, has died at the age of 83 years.

THE Rev. T. Neville Hutchinson, died on May 6th at the age of 73 years. Mr. Hutchinson was science master at Rugby from 1866-83 and did much to introduce the study of science in the English public schools.

THE Secretaries of the Sections of the American Association for the Advancement of Science are sending to members notices of the Colum-

bus meeting, which opens on August 21st. It is hoped that good programs may be arranged for the various sections at an early date.

THROUGH elections at the annual meeting on May 19th, and designations at the ensuing meeting of the Board of Managers, the organization of the National Geographic Society for the ensuing year was made as follows: President, Alexander Graham Bell; Vice-President, W J McGee; Treasurer, Henry Gannett; Recording Secretary, F. H. Newell; Corresponding Secretary, Willis L. Moore; Foreign Secretary, Eliza Ruhamah Scidmore; additional members of the Board, Marcus Baker, Charles J. Bell, Henry F. Blount, F. V. Coville, G. K. Gilbert, General A. W. Greely, Assistant Secretary David J. Hill, John Hyde, S. H. Kauffmann, Director C. Hart Merriam, Superintendent W. B. Powell, Superintendent Henry S. Pritchett and J. Stanley-Brown.

THE 12th International Congress of Orientalists will meet at Rome on October 12, 1899. Cards of membership (\$4.00) may be obtained from Mr. Cyrus Adler, Smithsonian Institution, Washington, D. C.

THE New York State Civil Service Commission announces that examinations will be held on June 9th and 10th, which will include the position of assistant in zoology in the State Museum, with a salary of \$900; the positions of sanitary, electrical and heating experts in the office of the State Architect, with salaries from \$1,200 to \$1,500; and the position of bridge designer and inspector in the State Engineer's Office, with a salary of from \$1,800 to \$2,400. The examination for an assistant in dietary experiments has been postponed to June 10th.

DR. DANIEL G. BRINTON, professor of American archaeology and linguistics at the University of Pennsylvania, has presented to the University his collection of books and manuscripts relating to the aboriginal languages of North and South America. The collection represents a work of accumulation of twenty-five years, and embraces about 2,000 volumes, in addition to nearly 200 volumes of bound and indexed pamphlets bearing on the ethnology of the American Indians. Many of the manuscripts are unique. A number of the printed

volumes are rare or unique and of considerable bibliographical importance. The collection of works on the hieroglyphic writings of the natives of this country embraces nearly every publication on the subject. The special feature of the library is that it covers the whole American field, North, Central and South, and was formed for the special purpose of comparative study.

THE collection of shells of the late Mr. Henry D. Van Nostrand, recently given to Columbia University, is well known among malacologists as one of the most valuable of private collections in the country; it contains the larger and better portion of the land shells of the West Indies collected by Thomas Bland, including many types, together with many of the rarest specimens of the Perry Expedition.

THE Technical Education Board of the London County Council is cooperating with the Asylums Committee in offering a scholarship of £150 a year, tenable for two years, for students of either sex (preferably qualified practitioners), to enable them to carry on investigations into the preventible causes of insanity. The scholar will carry on investigations in the pathological laboratory attached to Claybury Asylum.

PROFESSOR A. G. NATHORST, of the Imperial Museum of Natural History of Stockholm, with several scientific companions, sailed from Helsingfors on May 25th to search along the northeast coast of Greenland for Andrée. Professor Nathorst hopes to meet the *Fram* with Captain Otto Sverdrup.

MR. A. C. HARRISON, JR., Mr. W. H. Furness and Dr. H. M. Hiller, who recently returned from an exploration of Borneo, with collections for the University of Pennsylvania, are about to start on another expedition. They expect to make explorations in the northern part of Burmah and make archaeological and ethnological collections.

WE announced last week the laying of the foundation stone of the new building which is to complete the South Kensington Museum, hereafter to be officially known as the Victoria and Albert Museum. This building will contain the art and industrial collections, while new buildings for the Royal College of Science

will be begun at once. The sum of £300,000 has been appropriated for these buildings, which will occupy a position directly facing the Imperial Institute.

THE new building erected in the Dublin Zoological Gardens in memory of the late Professor Samuel Haughton was formally opened on May 19th by the Lord-Lieutenant, in the presence of a large gathering. Field-Marshal Lord Roberts, President of the Royal Zoological Society, described the purpose of the meeting and said that the new building was intended as a tribute to the memory of Dr. Haughton, whose name was intimately connected with many of the leading institutions in Dublin, but with none more closely than with the Royal Zoological Society, of which he had been five years President and 21 years Honorary Secretary.

THE City of Philadelphia has appointed a committee of expert engineers consisting of Rudolph Hering, of New York, Samuel Gray, of Providence, R. I., and Joseph L. Wilson, of Philadelphia, to make an investigation of the water supply of Philadelphia.

AN institute for the study of tropical medicine will be established at Berlin, with Dr. Koch as Director.

THE *Electrical World* abstracts from English journals an account of the early work of Professor Huges (inventor of the microphone), in wireless telegraphy by means of etheric waves; it appears to be the first published account of his experiments, which were made in 1879. He was experimenting with his microphone and induction balance, and found that the microphone produced a sound in the receiver even when it was placed several feet distant from the coils through which an intermittent current was passing and not in any other way connected. He found that the whole atmosphere, even in several rooms distant from there, would be invisibly changed and that this could be noticed with a microphone and telephone receiver. He experimented on the best form of receiver for these invisible electric rays, which he found would pass over great distances through walls, etc. He found that carbon contacts or a piece of coke resting on bright steel were very sensitive and self restoring receivers. A loose con-

tact between metals, while equally sensitive, required restoring. He also used the microphone as a relay in detecting such rays. He endeavored to discover the best receiver so as to utilize such waves for the transmission of messages. He showed his experiments to a number of well-known physicists at that time. The distance was 60 feet in the building, but he also took the instrument on the street, and walked away from the transmitter, obtaining signals up to 500 yards. He claimed the existence of the waves at that time, but was unable to convince others of their presence. He also calls attention to still earlier experiments of Professor Henry, of Princeton (U. S.), which were published by the Smithsonian Institution, Vol. I., p. 203, the date being probably about 1850; he magnetized a needle in a coil 80 feet distant; also by a discharge of lightning eight miles distant.

UNIVERSITY AND EDUCATIONAL NEWS.

THE election of Professor Arthur T. Hadley to the presidency of Yale University by the Corporation on May 25th marks the beginning of a new era in the development of a great university. Yale has adhered more closely than most of our larger institutions to the clerical and classical traditions of the American college, and President Hadley, while conserving what is good, will undoubtedly use his influence to make Yale, as a university, the equal of Harvard. Like the Presidents of Harvard, Johns Hopkins and Stanford Universities, President Hadley may be claimed as a man of science, his work on railway transportation and other subjects being strictly scientific in character.

CLARK University proposes to celebrate its decennial by special exercises beginning on July 5th. These will include lectures by eminent foreign men of science. Invitations to speak having been accepted by M. Émile Picard, professor of mathematics at the University of Paris and a member of the Institute; Dr. Angelo Mosso, professor of physiology at the University of Turin; and Dr. Santiago Ramon y Cajal, professor of histology and pathological anatomy at the University in Madrid.

A SPECIAL course in the fundamental problems of geology intended particularly for college

teachers will be offered during the first term of the summer quarter (July 1 to August 10, 1899) at the University of Chicago by Professor T. C. Chamberlin. This will embrace a discussion of the chief problems of geology involving basal principles and fundamental modes of interpretation. While old views will not be ignored, a special feature of the course will be a relatively new series of working hypotheses based upon the accretion theory of the earth's origin. These hypotheses will be carried out to their practical applications in the unsolved problems of geology and be made the basis of new modes of interpretation of geological history. The course will embrace an exposition of the stages of expansional, restrictional and provincial life evolution in the earth's history and the conditions controlling them. The functions of base-levels, sea-shelves, epicontinental seas, and continental stages of quiescence and readjustment in the control of life evolution, will be set forth. Parallel with the above there will be given a course in glacial geology involving a discussion of principles, the phenomena and modes of interpretation. These courses will be offered for the coming summer only, in response to an expressed desire for them. The usual courses in general geology and physiology, and in field and laboratory work, will be given by Professor Salisbury, aided by Messrs. Goode, Atwood, Calhoun and Finch.

THE Rhode Island College of Agriculture and Mechanic Arts, with the cooperation of Hon. Thomas B. Stockwell, State Commissioner of Public Schools, and Dr. Horace S. Tarbell, Superintendent of Schools in Providence, proposes to open a summer school for nature study at Kingston, R. I., from July 5 to 19, 1899, provided forty applicants are enrolled before June 1st. A general summer school is not contemplated, and the work offered by the various departments constitutes a single course dealing solely with local phenomena in their adaptability to the teaching of nature study. The distinctive feature will be the study of living nature. On the excursions attention will be directed to special facts and illustrations in botany, zoology, geography and mineralogy, and to the manner in which chemical, physical and biological laws are utilized by practical

application to horticulture and agriculture. The evenings will be devoted to general lectures bearing upon nature and upon methods of teaching nature study. Among those who have consented to aid by conducting excursions, conferences and lectures are Professors H. C. Bumpus, E. G. Conklin, H. W. Conn, C. B. Davenport and W. M. Wheeler.

THE Women's Medical College of New York will be closed at the end of the year, when the thirty-first annual commencement will be celebrated. When the College was established there was no opportunity for women to secure a medical education, but Johns Hopkins and Cornell having admitted women to their medical schools it has been decided that a special medical school for women is unnecessary. The infirmary for women and children will be continued, and the buildings of the College will be used for graduate work.

THE medical faculty of the University of Pennsylvania has made nominations as follows: Dr. James Tyson, professor of clinical medicine, to the chair of medicine, vacant by the death of the late Dr. Pepper; Dr. John H. Musser and Dr. Alfred Stangel, to be professors of clinical medicine; Dr. Judson Daland, Dr. M. Howard Fussell, Dr. John K. Mitchell and Dr. Frederick A. Packard to be assistant professors of medicine, and Dr. G. Davis to be assistant professor of applied anatomy.

DR. C. E. BEECHER, professor of historical geology in Yale University, has been appointed to succeed the late Professor O. C. Marsh as Curator of the Geological Collections of the Peabody Museum. Professor Beecher has been made a member of the Executive Council of the Museum.

At the University of Kansas the following appointments have been recently made: W. R. Crane, of Janesville, Wis., to be assistant professor of mining engineering; Thomas M. Gardner, of Mitchell, Ind., to be assistant professor of mechanical drawing; Dr. Ida Hyde, of Cambridge, Mass., to be assistant professor of zoology; Hamilton P. Cady, of Ithaca, N. Y., to be assistant professor of chemistry, and Charles L. Searcy, of the College of Montana, to be assistant professor of civil engineering.

SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; J. LE CONTE, Geology; W. M. DAVIS, Physiography; HENRY F. OSBORN, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; J. McKEEN CATELL, Psychology; DANIEL G. BRINTON, J. W. POWELL, Anthropology.

FRIDAY, JUNE 9, 1899.

SENATORIAL INVESTIGATION OF FOOD ADULTERATION.

CONTENTS:

<i>Senatorial Investigation of Food Adulteration</i>	793
<i>Amerind—A Designation for the Aboriginal Tribes of the American Hemisphere</i>	795
<i>Exploring Expedition to the Mid-Pacific Ocean: DR. HUGH M. SMITH</i>	796
<i>The Scientific Study of Irrigation: DR. A. C. TRUE</i>	798
<i>The International Catalogue of Scientific Literature—Second Conference (II.): DR. CYRUS ADLER</i>	799
<i>A Double Instrument and a Double Method for the Measurement of Sound: DR. B. F. SHARPE</i>	806
<i>New York State Science Teachers Association: DR. FRANKLIN W. BARROWS</i>	811
<i>Scientific Books:—</i>	
<i>Urkunden zur Geschichte der nichteuklidischen Geometrie: PROFESSOR GEORGE BRUCE HALSTED. Lachman's The Spirit of Organic Chemistry: DR. JAMES F. NORRIS. Allen's Commercial Organic Analysis: PROFESSOR W. A. NOYES. Books Received</i>	813
<i>Societies and Academies:—</i>	
<i>Section of Geology and Mineralogy of the New York Academy of Sciences: DR. ALEXIS A. JULIEN. Torrey Botanical Club: EDWARD S. BURGESS. The New York Section of the American Chemical Society: DR. DURAND WOODMAN</i>	818
<i>Discussion and Correspondence:—</i>	
<i>Larval Stage of the Eel: DR. THEO. GILL</i>	820
<i>Scientific Notes and News</i>	820
<i>University and Educational News</i>	824

DURING the closing session of the last Congress, the Senate authorized the Committee on Manufactures to conduct a recess investigation on the subject of the extent and character of food adulteration in the United States. By reason of expiration of the term of service, only three members of the Senate Committee on Manufactures remained, namely, W. E. Mason, Chairman, of Illinois; W. A. Harris, of Kansas, and G. P. Wetmore, of Rhode Island. Under the terms of the resolution it is not necessary to have a quorum of the Committee, but the Chairman or any member designated by him is empowered to conduct the investigation, procure witnesses and to secure the analyses of suspected samples.

The Committee has already begun its work by holding a two weeks' session in Chicago. Dr. H. W. Wiley, the Chief Chemist of the Department of Agriculture, at the request of the Committee, has been detailed by the Secretary of Agriculture as an expert to attend the examinations and to assist in the work as far as possible.

Much interesting testimony was secured at the meeting in Chicago in regard to the extent and character of food adulteration.

Not only were business men who were engaged in adulteration placed upon the stand, but also some well-known hygienic and scientific experts, among whom may be

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

mentioned Professor A. B. Prescott and Dr. V. C. Vaughn, from the University of Michigan.

Dr. Wiley was placed first upon the stand, and gave an outline of the character and extent of food adulteration as it has been revealed through the many years of investigation in the Chemical Division of the Department of Agriculture. Manufacturers of 'pure Vermont maple sugar' testified, under oath, that much of the product that they sold contained not more than 25 per cent. of maple sugar or syrup. When asked in regard to the purity of the maple sugar which they bought for mixing purposes they testified that they believed it to be pure, but were by no means certain. Glucose is the usual adulterant for maple syrup, although melted brown sugar is sometimes employed where a thinner product, more nearly resembling maple syrup, is desired. It was testified that when retail dealers desired maple syrup for their customers they specified the price they were willing to pay, and that the mixing was then done according to that price.

Manufacturers of jellies also testified that the cores and skins from cider factories and drying kilns were employed as the base of much of the pure fruit jellies manufactured and sold. Glucose is used as the principal filler in these jellies, and the color and flavor are largely supplied by synthetic products. The quantity of these adulterated goods made is far greater than that of the pure article.

Professor A. S. Mitchell, Chief Chemist of the State Board of Health and Pure Food and Dairy Commissioner of Wisconsin, was a valuable witness before the Committee. He brought with him samples of adulterated goods secured in the State of Wisconsin, and explained in detail the nature of the adulteration as it had been disclosed by his analyses. He described particularly the antiseptics and preservatives

which were on the market under various trade names, such as 'freezem' and 'freezine,' and so forth. 'Freezem' was shown to be a dilute solution of formaldehyde, while 'freezine' was composed chiefly of sodium sulphite. The question of the use of preservatives was discussed by the experts before the Committee, and the universal opinion was expressed that they were all unwholesome. Since, however, there are certain articles of food and condiments, such as cider, tomato catsup, etc., which require some preservative in order to prevent fermentation; and inasmuch as it was brought out in the evidence that in the shipment of butter from Australia to English ports the use of boric acid was quite universal and was not objected to by the English customers, and as it was further stated in the evidence that English merchants required that hams sent to England from a distance should be rubbed with boric acid, the experts unanimously agreed that it would not be wise to pass a law prohibiting the use of all preservatives, but that thorough investigation should be made to determine which kinds of preservatives are least objectionable, and that in all cases any article of food, drink or condiment containing a preservative should have that fact plainly stated on the label and the quantity thereof indicated.

It was brought out in the evidence that the oleomargarine law was practically violated in many parts of Chicago. One witness before the Committee went to five grocery stores and asked for creamery butter. In each case he received oleomargarine. In each case the wrapper, which, according to law, should bear the word 'oleomargarine,' plainly visible, was so arranged that the purchaser could not possibly see the word. The plan was to stamp the word 'oleomargarine' near the corner of the wrapper and then to fold the corner of the wrapper over so that the stamp

would be invisible. One of the dealers selling these packages was brought before the Committee and testified that some of the richest people living in Chicago were his customers, buying this substance and knowing that it was oleomargarine, but who desired that the fact of its use by them should be kept secret.

The ethics of coloring butter and oleomargarine was also discussed before the Committee, and it was brought out in evidence that if oleomargarine was colored pink or any other color than butter color its use as butter would be practically destroyed.

Evidence was also given in the matter of making artificial whiskies from cologne spirits, burnt sugar and the ethers of the organic acids, together with the essential oil to give the proper head. It was developed that the trade in these synthetic drinks was very large, and that the natural products suffer severely in competition.

Much testimony was also given in regard to the adulteration of the ordinary condiments, such as ground pepper, mustard, cinnamon and so forth. It appeared that these bodies were largely mixed with inert matter, so that the purchaser would really get very little of the condiment which he desired. It was shown that ground coffee was mixed largely with chicory and other substances, and that the coffee bean was mixed with an artificial bean or with a certain proportion of the dead or imperfect beans, which were not only useless for flavoring the beverage, but, on the other hand, were bitter and unpalatable.

The session of the Committee in Chicago had for its object the outlining of the scope of the investigation which will be continued during the summer months in other localities of the United States. The final purpose of the Committee is to obtain material on which to base a report in favor of a national pure food and drug bill, having for

its object the regulation of traffic in the adulteration of food in the District of Columbia and the Territories and the control of inter-State commerce in adulterated food and drug products.

AMERIND—A DESIGNATION FOR THE ABORIGINAL TRIBES OF THE AMERICAN HEMISPHERE.

A PART of the proceedings of the Anthropological Society of Washington, at a meeting on May 23d last, seem destined to produce permanent influence on ethnologic nomenclature; this part of the proceedings taking the form of a symposium on the name of the native American tribes. The discussion was opened by Colonel F. F. Hilder, of the Bureau of American Ethnology, with a critical account of the origin of the misnomer 'Indian,' applied by Columbus to the American aborigines; he was followed by Major J. W. Powell, who advocated the substitution of the name *Amerind*, recently suggested in a conference with lexicographers. A communication by Dr. O. T. Mason followed, in which the various schemes of ethnologic classification and nomenclature were summarized and discussed. Contributions to the symposium were made also by Dr. Albert S. Gatschet, Dr. Thomas Wilson and Miss Alice C. Fletcher. At the close of the discussion the contributions were summarized (by President McGee) as follows:

1. There is no satisfactory denotive term in use to designate the native American tribes. Most biologists and many ethnologists employ the term 'American'; but this term is inappropriate, in that it connotes, and is commonly used for, the present predominantly Caucasian population. The term 'Indian' is used in popular speech and writing, and to a slight extent in ethnologic literature; but it is seriously objectionable in that it perpetuates an error, and for the further reason that it connotes

and so confuses, distinct peoples. Various descriptive or connotive terms are also in use, such as 'North American savages,' 'Red Men,' etc.; but these designations are often misleading, and never adapted to convenient employment in a denotive way.

2. In most cases the classifications on which current nomenclature are based, and many terms depending on them for definition, are obsolete; and the retention of the unsuitable nomenclature of the past tends to perpetuate misleading classifications.

3. While the name 'Indian' is firmly fixed in American literature and speech, and must long retain its current meaning (at least as a synonym), the need of scientific students for a definite designation is such that any suitable term acceptable to ethnologists may be expected to come into use with considerable rapidity. In this, as in other respects, the body of working specialists forms the court of last appeal; and it cannot be doubted that their decision will eventually be adopted by thinkers along other lines.

4. As the most active students of the native American tribes, it would seem to be incumbent on American ethnologists to propose a general designation for these tribes.

5. In view of these and other considerations, the name *Amerind* is commended to the consideration of American and foreign students of tribes and peoples. The term is an arbitrary compound of the leading syllables of the frequently-used phrase 'American Indian'; it thus carries a connotive or associative element which will serve explicative and mnemonic function in early use, yet must tend to disappear as the name becomes denotive through habitual use.

6. The proposed term carries no implication of classific relation, raises no mooted question concerning the origin or distribution of races, and perpetuates no obsolete idea; so far as the facts and theories of

ethnology are concerned, it is purely denotive.

7. The proposed term is sufficiently brief and euphonious for all practical purposes, not only in the English but in the prevailing languages of continental Europe; and it may readily be pluralized in these languages, in accordance with their respective rules, without losing its distinctive semantic character. Moreover, it lends itself readily to adjectival termination in two forms (a desideratum in widely-used ethnologic terms, as experience has shown), viz.: *Amerindian* and *Amerindic*, and is susceptible, also, of adverbial termination, while it can readily be used in the requisite actional form, *Amerindize*, or in relational forms, such as *post Amerindian*, etc.; the affixes being, of course, modifiable according to the rules of the different languages in which the term may be used.

8. The term is proposed as a designation for all of the aboriginal tribes of the American continent and adjacent islands, including the Eskimo.

The working ethnologists in the Society were practically unanimous in approving the term for tentative adoption, and for commendation to fellow students in this and other countries.

EXPLORING EXPEDITION TO THE MID-PACIFIC OCEAN.

THE unusual activity now being exhibited by various European governments in scientific exploration of the seas is soon to be supplemented by the United States, for arrangements are being perfected by the United States Commission of Fish and Fisheries for one of the most important marine scientific expeditions ever undertaken in this country. The association of the name of Professor Alexander Agassiz with the expedition is a guarantee of its high scientific standing, and the employ-

ment of the Fish Commission steamer *Albatross* ensures the proper paraphernalia for marine research.

The objective points of the expedition are certain groups of islands in the middle of the Pacific Ocean, of both sides of the equator, about whose local fauna little is known, and in the waters contiguous to which little or no scientific investigation has been conducted.

The *Albatross* will sail from San Francisco about the middle of August, and proceed directly to Tahiti, in the Society Islands, possibly touching at the Marquesas Islands for coal. On this trip of 3,500 miles, dredging and sounding will be carried on at regular intervals on an almost wholly unexplored section of the sea bottom.

Tahiti will be made the headquarters while the Paumotu Islands are being explored. In this archipelago, which is about 600 miles long, the *Albatross* will pass six or eight weeks, and important scientific discoveries should be made, as the natural history of the region is practically unknown.

After returning to the Society Islands the vessel will go to the Tonga, or Friendly Islands, a distance of about 1,500 miles, where a week or ten days will be spent. Thence the vessel will sail for the Fiji Islands, where a short stay will be made, and thence 1,700 miles to the Marshall Islands, visiting a number of the Ellice Islands and Gilbert Islands on the way. Six or seven weeks will be devoted to the exploration of the Marshall Islands, about whose fauna almost nothing is known.

Between the Marshall Islands and the Hawaiian Islands, and between the latter and San Francisco, a distance of over 4,000 miles, a line of deep-sea dredgings will be run, deep-sea tow-nets being used while the dredging is going on. This work is expected to be one of the most interesting features of the expedition.

The *Albatross* is expected to return to the

United States about April 10, 1900, after a voyage of 20,000 miles.

Every effort is being made to thoroughly equip the vessel for deep-sea dredging, trawling and sounding; surface and intermediate towing; shore seining; fishing trials with lines and nets; land collecting, and other branches of the work. The newest apparatus for deep-sea and plankton investigations will be supplied. Special appliances are being constructed for use in the very deep water to be found about some of the islands, and it is expected that the dredge will be hauled at a greater depth than has heretofore been attempted. The *Albatross*, since her return to the Fish Commission by the Navy Department, on the conclusion of the Spanish-American War, has been undergoing extensive repairs and improvements, including the installation of new boilers, the building of an ice-making machine and cold-storage plant, electric fans, etc., and will, on this expedition, more than ever deserve the reputation of being the best equipped vessel in existence for scientific research.

The personnel of the expedition will be as follows: Professor Alexander Agassiz, in charge of the scientific work, accompanied by his son; Lieutenant Commander Jefferson F. Moser, United States Navy, commanding officer of the *Albatross*, in charge of topographical surveys; Dr. H. F. Moore, chief naturalist of the *Albatross*; Mr. Charles H. Townsend, late naturalist of the *Albatross*; Dr. W. McM. Woodworth and Dr. A. G. Mayer, Museum of Comparative Zoölogy, Cambridge, Mass.; Mr. A. B. Alexander, United States Fish Commission, fishery expert; Mr. H. C. Fassett, United States Fish Commission, photographer. The vessel is manned by ten officers and seventy petty officers and enlisted men of the United States Navy.

The Department of State evinces a lively interest in the expedition, and has through

our ambassadors communicated with the British, French and German authorities for the purpose of having the representatives of those governments instructed to accord special privileges to the *Albatross*. The President has cordially approved the assignment of the vessel to this work.

In a recent letter Professor Agassiz refers to his explorations in the Bahamas, the Bermudas, Cuba, Florida, the Fiji Islands, the Australian Great Barrier Reef, the Sandwich Islands, the Bay of Panama, the Galapagos Archipelago and the Gulf of California, and then says:

The expedition now proposed I consider the most important one I have undertaken since the cruise of the 'Blake' in 1877-80. It covers an area of the Pacific which has not as yet been touched, as nothing is known of the line San Francisco to Tahiti, Tahiti to Fiji, Ellice and Jaluit, and Marshall Islands to Honolulu; and most important results should be obtained with a vessel so admirably fitted for the work as the *Albatross*. In addition to the deep-sea work, we expect to visit many of the atolls and elevated reefs abounding along our track, and hope to throw additional light on the debatable theory of coral reefs. The proposed *Albatross* expedition is one which, with fair success, is sure to be creditable to this country. Since the great exploring expedition of Wilkes this government has done but little in the greater field of oceanic exploration as a whole, though the minor expeditions undertaken in connection with the work of the Coast Survey and the Fish Commission have been among the most satisfactory explorations of limited areas of our coast.

It is the intention to have the Fish Commission and the Museum of Comparative Zoölogy jointly publish the reports embodying the results of the expedition.

HUGH M. SMITH.

U. S. COMMISSION OF FISH AND FISHERIES.

THE SCIENTIFIC STUDY OF IRRIGATION.

THE appropriation for the irrigation investigations in charge of the Office of Experiment Stations, Department of Agriculture, having been increased at the recent session of Congress from \$10,000 to \$35,000, of which sum \$10,000 was made immedi-

ately available, these investigations are being further developed and the work in connection with them is being more thoroughly organized. The scope of the investigations has been more accurately defined in the last appropriation act. As there stated, funds are provided "To enable the Secretary of Agriculture to investigate and report upon the laws and institutions relating to irrigation, and upon the use of irrigation waters, with special suggestions of better methods for the utilization of irrigation waters in agriculture than those in common use, and for the preparation, printing and illustration of reports and bulletins on irrigation; and the agricultural experiment stations are hereby authorized and directed to cooperate with the Secretary of Agriculture in carrying out said investigations in such manner and to such extent as may be warranted by a due regard to the varying conditions and needs of the respective States and Territories, and as may be mutually agreed upon."

The first bulletin prepared in connection with these investigations, which has recently been issued, contains a discussion of the irrigation laws which control the diversion and use of water from the Missouri River and its tributaries, by Professor Elwood Mead, including papers on the water laws of Colorado and Nebraska, by the engineers of these States. Other bulletins of a similar character are in preparation.

For the present the investigations on the use of irrigation water will be largely confined to the determination of the actual amount of water used by successful farmers in different parts of the irrigated region on different soils and in the growing of different crops.

A temporary organization for the administration of these investigations has been effected by the appointment of Professor Elwood Mead as irrigation expert in charge,

and headquarters have been established at Cheyenne, Wyoming. It is hoped that some work may be done during the present season in most of the States and Territories west of the Mississippi River in which irrigation is practiced to any considerable extent. Arrangements have also been made to aid the New Jersey experiment stations in continuing their investigations, which have already attracted much favorable attention in the East.

As far as practicable the cooperation of the experiment stations will be sought in these investigations, and it is to be hoped that one result of this work will be that the stations will not only be able to develop their investigations relating to irrigation in the lines in which the Department will work under this appropriation, but also in other important lines involving operations by different divisions of the station. It is believed that, by concentrating their efforts on problems based on the requirements of agriculture under irrigation, the stations in a number of States and Territories may materially enhance their usefulness.

It should be clearly understood that the irrigation investigations of this Department are intended to cover only a limited portion of the field of investigations relating to agriculture under irrigation which the stations and the different divisions of the Department may properly undertake. An effort will be made to mark out a line of work for these investigations which will give them a distinct place between the investigations of the Geological Survey relating to the topography and water supply of the irrigated region, and those of the different branches of the Department and stations which relate to the climate and plants of that region. Aside from the studies of the laws and institutions of communities in which irrigation is practiced, the irrigation investigations will have for their chief ob-

ject the determination of the economic and profitable utilization of water in agriculture as it is supplied to the farmer through reservoirs, canals and ditches. In these investigations, as in nearly all others relating to the complex science of agriculture, there will be many points of contact with investigations conducted under other auspices, and thus many opportunities for co-operative effort will be presented. With so large a field of operations and so great interests at stake, there will be abundant room for all the agencies now at work for the benefit of agriculture of the irrigated region to fully utilize all the means at their command. Besides the development of the irrigation investigations, the Department will, for example, continue studies of alkali soils, the native and cultivated plants and trees best adapted to the arid regions, and other related questions.

The people of that vast area of our country in which agriculture and the other industries are so largely dependent on the successful practice of irrigation are to be congratulated that attention was more earnestly and successfully drawn to their needs during the recent session of Congress than ever before, and more ample provision than heretofore was made for studying the problems of agriculture in that region, through increased appropriations for the work of the Geological Survey and different branches of the Department of Agriculture.

A. C. TRUE,
Director.

THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.—SECOND CONFERENCE.

II.

It becoming apparent that no early conclusion would be reached, based on the resolution of Professor Armstrong, it was withdrawn, and Dr. Adler moved "That the registration symbols used in the Cata-

logue be based on a system of letters and numbers, adapted in the case of each branch of science to its individual needs." Professor Darboux proposed the expression 'of letters or of numbers.' Dr. Adler explained his motion by saying that the use of letters and numbers which would furnish the opportunity of alternating gave a greater elasticity to the system than the use of either one by itself.

Chevalier Descamps objected to the terms of the resolution as restricting the Catalogue to the use of letters and numbers as symbols, whereas it might be found desirable to employ other symbols. Professor Armstrong thought that this construction need not be placed on the words, the idea being that letters and numbers were the fundamental symbols.

Professor Darboux said that the real matter to arrive at was a scheme of classification suited to present needs, and of whose durability one might be assured. After some further discussion Dr. Adler made a further explanation as to the object of his resolution. The first Conference had discussed the subject of classification and symbols, and not being able to arrive at any conclusion had referred the matter to the Royal Society. The Society had appointed a committee, which, after long labor, had presented a report, and thus far the Conference had done nothing but criticise it. He did not think it desirable or possible to discuss further detail. The resolution moved was broad and in general terms with the idea that its interpretation and details be left to the persons in whose charge the execution of the Catalogue would actually be. In order, however, to get further advice on the subject he would later on move a provision for an international committee and give the scientific men of the various countries an opportunity to pass on the details of classification.

Professor Klein (Germany) strongly ap-

proved of the appointment of an international committee and of special committees in the various countries, and supported the resolution with a suggestion as to verbal modification.

Dr. Heller spoke in recognition of the work of the Royal Society and supported the statement of Professor Klein and others, that the various sciences had different needs. After remarks by Dr. Graf the resolution was slightly amended by inserting the words 'or other symbols' in addition to letters and numbers.

M. Otlet asserted that the lack of uniformity in the system proposed would result in great inconvenience. Professor Darboux thought the whole matter not of great importance and going too much into detail. Professor Armstrong, however, stated that such a resolution was very much desired by the Royal Society, as it would clear the field. The Committee was of the opinion that the different sciences require different treatment, subject to a general uniformity.

Dr. Adler stated that his resolution did not at all require that each science should have a different scheme of classification or registration. He maintained, however, that the arrangement should be from the point of view of the scientific man, and not of the classifier. If they could agree on a single uniform scheme so much the better.

Professor Klein supported this view, holding that it was important to pass on to the next matter relating to the appointment of committees for the study of the schedules.

Chevalier Descamps asserted that the resolution would result in more inconveniences than advantages. He stated that he and his colleagues of the International Office of Bibliography at Brussels were in a peculiar position. Without wishing to disparage the work done in any other country, he would say that they had collected two

million slips and that most of their work was proved by results which were here being ignored.

Dr. Adler reiterated it as his intention that as far as possible, a uniform system of registration be adopted. Chevalier Descamps proposed adding words to this effect, asserting that classification was also a science with its own laws. From this Dr. Adler dissented, stating his view that classification and notation were simply convenient tools for sciences. The resolution was then unanimously agreed to, with the modifications proposed, reading as follows :

"That the registration symbols used in the Catalogue be based on a convenient combined system of letters, numbers or other symbols adapted, in the case of each branch of science, to its individual needs, and in accordance, as far as possible, with a general system of registration."

The second proposition of Dr. Adler was "That the authoritative decisions as to the schedules be intrusted to an International Committee, consisting of the following: Professor Darboux, Professor Klein, Professor Weiss, Dr. S. P. Langley, Professor Korteweg and Dr. Graf, together with three representatives of the Royal Society; that the Committee be instructed to consult with experts in each science and to frame within six months a report, which shall be issued by the Royal Society and incorporated in the decisions of the Conference."

Dr. Brunchorst agreed with the resolution in principle, but stated that the sciences were not equally represented.

Professor Darboux thought that the question raised by this resolution was a central one for the Conference. It was a pity that some practical step of this sort had not been taken at the previous Conference requesting the states to form a sort of embryo of Regional Committees which might have placed themselves in relation with the Royal Society.

Professor Korteweg pointed out that the resolution meant the nomination of a central commission to control, as far as possible, the different projects of classification. This commission need not contain representatives of all sciences, especially as it had the authority to secure the aid of special committees.

Professor Darboux thought it best that the official representatives at the Conference should constitute the local or regional committees of classification.

Dr. Bernoulli thought that the Conference had approached its second important question—that of organization. With regard to the first question—that of classification—he fully agreed with Dr. Darboux that it should be settled by the specialist in each branch of science for his own subject. The central committee proposed by the representative of the United States should have to do only with notation. Switzerland, he said, could not constitute a regional bureau or committee. But to a central committee of this sort he agreed, if it were made representative of the libraries as well as the sciences, and if the Director of the Bibliographical Institute at Brussels were included.

Professor Klein desired to bring the Conference back to the principal point as to how the classification of the schedules was to be made. It had been the intention to hold a conference of scientific men in Berlin for the purpose of arriving at some opinion, but this had been delayed, though the idea was not given up, and the plan of arriving at opinions, at least so far as Germany was concerned, seemed quite feasible to him.

Professor Weiss thought the resolution of the delegate from America quite agreed with Professor Klein's idea. Professor Rücker supported a resolution of this nature. He thought that the next scheme published should have some international weight.

Chevalier Descamps agreed in the main with the plan, though he remarked, in passing, that Belgium was not represented on the Committee. Professor Darboux and Dr. Graf discussed the best method of arriving at the opinions of the scientific men in the various countries. Dr. Mond thought the delegates from the various countries were the best medium for establishing the Committees; otherwise he favored the appointing of an International Committee as the best means of arriving at a definite conclusion—a view which was supported by Professor Klein.

M. Mascart requested permission to present the following resolution: "The Conference is of the opinion that the delegates be requested to take steps in their respective countries to organize local commissions charged to represent the Royal Society in the various countries; to study all questions relative to the International Catalogue of Scientific Literature, and to send a report to the International Committee."

Professor Foster favored the resolution introduced by Dr. Adler. The Royal Society had done its best, and the matter should now be left to a broader court, this latter body to be an authoritative one empowered to make final decisions. He did not regard this commission as representing different countries, but simply as composed of men chosen by this Conference.

Dr. Bernoulli suggested that the schedules be submitted to the various International Congresses, such as the Mathematical, Zoological and Chemical, etc.

Professor Foster replied that the Congresses of Zoology and Physiology met only once in three years. The matter had been brought to the attention of the Congress of Physiology, but not seriously discussed. He thought a Congress the worst body possible to which to submit the questions.

M. Mascart stated that after hearing the discussion he desired to modify his amend-

ment in the following manner: "The Conference holds the view that the delegates be requested to take steps through the governments of their respective countries to organize local commissions charged with studying all the questions relative to the cataloguing of scientific literature of the Royal Society, and to send a report in six months to an International Committee constituted under the patronage of the Royal Society. The International Committee shall examine all the solutions sent and reach a definite decision."

Professor Klein agreed with the proposition, pointing out, however, that the time allowed was too short, and declaring that any connection with International Scientific Congresses was impracticable, as they had no permanent organization. The debate continued for some time, and finally the first portion of Dr. Adler's motion, modified by Professor Klein, "That the authoritative decisions as to the schedules be intrusted to an International Committee to be hereafter named by the Conference, together with three representatives of the Royal Society," was unanimously agreed to. The resolution of M. Mascart concerning the appointment of local committees to report in six months was next adopted, and a further resolution that the International Committee frame its report not later than July 31, 1899.

Professor Boltzmann brought up the subject of some additional classes to be added to the list of sciences, more especially a class of general science. Professor Foster objected to having the subject reopened, and after a lengthy discussion the President ruled the discussion out of order; which, it may be said, was the single case of such a ruling at the Conference.

President Foster next raised the question of the functions of the regional bureaux. Dr. Graf stated the difficulties which were in the way of the organization of a regional

bureau in Switzerland, and thought it best that all the work be done by a central bureau. Professor Rücker pointed out that it would probably be easier for the various countries to find the money to pay for work done within their own borders. He also thought that in time authors could be got to prepare their own analyses. Dr. Bernoulli agreed with the opinion of his colleague. Dr. Graf and M. Otlet also supported the idea of a single central bureau. Professor Darboux, however, warmly upheld the decision reached at the first Conference, of having a central bureau and regional bureaus. All the resolutions relating to this subject as well as to the business conduct of the bureau were finally adopted, or referred to the International Council. They are given in the *Acta* and need not be referred to here.

The next matter of importance was with regard to the persons who should form the International Committee.

This was discussed at length, informally (the discussion not being reported), and it was finally agreed that the members be Professor Armstrong, Chevalier Descamps, Professor M. Foster, Dr. S. P. Langley, Professor Poincaré, Professor Rücker, Professor Waldeyer and Professor Weiss, with the understanding that the Committee may appoint substitutes, should any member be unable to serve, and that it have the privilege of adding two members.

M. Mascart then called attention to the desirability of the passage of a resolution which would give the Central Bureau the power of modifying decisions of the Conference, should they be found impracticable; and this, after discussion, was agreed to. There were some further remarks about the arrangement of the various sciences, which resulted in no formal action, it being held that the International Committee was competent to deal with these matters.

The final sitting of the Conference was

devoted to the consideration of the finances of the Catalogue.

Professor Rücker, on behalf of the Royal Society, stated that, while they had not gone into the matter in great detail, they were of the opinion that their estimates were approximately correct. The cost of producing the Book Catalogue was, in round numbers, £5,600. The least remunerative number of complete subscribers would be 350, taking the average of the complete subscription of £16. For the Primary Slip Catalogue a further £3,000 per annum would be necessary, which would be met by 130 complete subscriptions. This estimate is based upon the use of the linotype system. The Secondary Slip Catalogue would cost, in round numbers, £6,000 per year. If the scheme were carried out on this scale it would be possible to supply 133 cards for a franc, or 160 cards for a shilling. It was the hope of the committee that the Catalogue would ultimately pay its own way, though some plan must be found for guaranteeing its success. One way would be to receive direct subscriptions from foreign countries, as is done in the case of other international bureaus, or a guarantee fund might be established. The minimum period of experiment for the Catalogue would be fixed at five years, and should the entire scheme for books and cards be entered upon, a sum like £40,000 would have to be guaranteed to make sure of the success of the plan for the period of five years. This would be met if, say, ten of the great powers each take one share, the smaller powers two between them and the English colonies one amongst them; each share would then amount to £4,000 in the course of five years.

The delegates of the various countries were then requested to state what their countries might be expected to do.

Professor Klein, for Germany, stated that he was in no wise authorized to enter into

any engagements; he said, however, that at a recent conference of German scientific men it had been decided to recommend to the German government a subvention of 12,000 Marks per annum for the regional bureau; he was also prepared to recommend a subvention of £1,000 for the central bureau.

Professor Weiss stated that the Austrian government had agreed to provide fully for the expense of a regional bureau. The Vienna Academy was prepared to recommend a subvention of £200.

Doctor Heller said, in the name of the Hungarian government, that he had been authorized to state that the regional bureau for Hungary would be completely provided for at the expense of the Hungarian Academy of Science. He was not prepared to make any statement with regard to the guarantee fund.

Professor Darboux stated for France that his country would undertake the organization of a regional bureau, but with regard to a subvention he thought it difficult to obtain it outright; it might be much more feasible to accomplish the same result by guaranteeing a subscription to a certain number of copies of the Catalogue. Professor Rücker stated that such an arrangement with regard to subscriptions would be equivalent to a guarantee and would be satisfactory.

Doctor Adler stated, on behalf of the United States, that he was not authorized to make any agreement in regard to expenses; that in accordance with the recommendation of Dr. Billings and Professor Newcomb, delegates to the previous Conference, the Secretary of State had asked an appropriation of £2,000 per annum for the establishment of a regional bureau. He did not think that in any event the United States government could be brought to contribute to a guarantee fund, and if this were necessary it could be done more

readily through universities and scientific societies, and that the most feasible plan for the United States was that suggested by Professor Darboux, a given number of subscriptions to the Catalogue.

Dr. Graf, speaking for Switzerland, stated that he was prepared to make no promises, but that the plan suggested by Professor Darboux, to have his government subscribe for a given number of copies of the Catalogue, would be the one most easily carried out in his country.

Chevalier Descamps stated that he had no instructions from his government, but thought that the proposition made by Professor Darboux, that is, a subscription of a given number of copies, was one that Belgium would be most likely to carry out.

No definite statements were made on behalf of Norway, Sweden and Japan, the delegates being without instructions.

Sir John Gorst, speaking for Great Britain; stated that he too was without authority to pledge his government, but thought that the British government would be more likely to subscribe for a number of copies of the Catalogue than to give a guarantee.

It was suggested by Professor Foster that the delegates be requested to obtain information at an early date as to what assistance might be expected from their respective countries towards the expenses of the central bureau.

M. Mascart thought that the plan was still too indetermined to make the question of expense sufficiently definite. Professor Klein also seemed to think this somewhat premature; that the whole matter depended as to whether the scheme for the Catalogue could be brought into such form that one might say: "This is good, and we agree that it should be done in this way."

Dr. Graf desired that the Provisional International Committee should take the opportunity of examining the bibliographical

work now in actual operation in Switzerland, mentioning that of Dr. Field.

It was agreed further that the time of calling the Provisional International Committee together be left to the Royal Society.

Some discussion arose at this point with regard to the meaning of Article 22, as to whether the delegates continue to exist as delegates after the adjournment of the Conference. There was a joint agreement that the committees should be appointed by the delegates, and the report of these committees transmitted by the delegates.

After a vote of thanks to the Society of Antiquaries, and to the President, Sir John Gorst, the Conference adjourned.

It would seem ungracious not to mention the very pleasant hospitalities of the Royal Society, which gave a dinner to the delegates, presided over by its distinguished President, Lord Lister, and of the English delegates, who also gave a dinner, presided over by Sir Norman Lockyer.

The delegates had frequent meetings outside of the regular meetings of the Conference, which fact expedited the work. There was no division or national lines, all the conclusions being reached either as a result of the individual opinions of those present or based upon conditions existing in the country of the particular delegate.

The official Acta of the Congress were printed in the issue of SCIENCE for November 11, 1898.

On returning from abroad I submitted the accompanying report to the Secretary of State:

WASHINGTON, November 15, 1898.

SIR:

Having been appointed, together with Mr. S. P. Langley, Secretary of the Smithsonian Institution, a delegate on the part of the United States to the Conference on an International Catalogue of Scientific Literature, to be held at London on July 12, 1898, we proceeded abroad on July 2nd.

The British Government found it expedient to postpone the conference until October 11. At the re-

quest of the Department, and with the consent of the Secretary of the Smithsonian Institution, I continued abroad and attended the Conference. Mr. Langley's official duties necessitated his return to the United States in September.

The deliberations were in continuation of those had at a previous Conference in 1896, at which this Government was also represented. Satisfactory conclusions were reached, leaving only such questions as can be definitely determined by an International Committee, on which the United States is represented by Mr. Langley.

I have the honor to transmit herewith the Acta of the Conference. The *procès verbal* will be issued later, and a copy forwarded to the Department.

I beg most respectfully to bring to your notice the report of the delegates of the United States to the first Conference (Professor Simon Newcomb and Doctor J. S. Billings) to repeat the recommendations made by them, and to further draw your attention to the recommendation of the Secretary of the Smithsonian Institution, all of which is contained in Senate Document No. 43, 54th Congress, 2nd session, a copy of which is herewith appended.

I have much pleasure in informing you that both in public and privately, the Delegates of the United Kingdom, and of other Powers, expressed a very generous appreciation of the scientific activity of the United States, and I beg to be allowed to commend to the favorable consideration of the Department, the recommendation of such legislation as will enable the United States to worthily take its share in this highly important International project.

I have the honor to be

Sir, Your most obedient servant,

(Signed) CYRUS ADLER.

THE HONORABLE,

THE SECRETARY OF STATE.

His reply is given herewith:

L/S

DEPARTMENT OF STATE,

Washington, November 25, 1898.

PROFESSOR CYRUS ADLER,

Smithsonian Institution, Washington, D. C.

SIR: I have to acknowledge the receipt of your letter of the 15th instant in regard to the work of the Conference on an International Catalogue of Scientific Literature which met at London on the 11th ultimo and to which you were a delegate on the part of the United States.

With reference to your suggestion that such legislation be recommended to Congress as will enable the United States to worthily take its share in this highly useful and important international project, I have to state that I had already in the estimates for this De-

partment for the fiscal year ending June 30, 1900, submitted an item of \$10,000, or so much thereof as may be necessary, for the purpose of carrying out on the part of the United States the recommendation of the International Conference on a Catalogue of Scientific Literature, and for the expense of clerk hire and for the other expenses of the work of cataloguing the scientific publications of the United States, the same to be expended under the direction of the Secretary of the Smithsonian Institution, and pointed out that as the preparation of the catalogue is to begin on January 1, 1900, it would be necessary for appropriate action to be taken by Congress at its forthcoming session, if this Government is to participate therein.

In support of this recommendation, I enclosed as appendices a copy of the Congressional document to which you refer and a copy of your report on the Conference of 1896. The estimates are now in print and it is too late to have your present letter included therein; but I shall, upon the assembling of Congress, communicate it to that body in further support of the item.

I am Sir,
Your obedient servant,
(Signed) JOHN HAY.

The following additional communication from the Department has also been received :

T W DEPARTMENT OF STATE,
Washington, December 16, 1898.
DR. CYRUS ADLER,

Delegate of the United States to the Second International Conference on a Catalogue of Scientific Literature, Smithsonian Institution.

SIR : I enclose for your information copy of a note from the British Ambassador at this capital, conveying to this Government an expression of the grateful appreciation of the President and Council of the Royal Society for the cordial coöperation of the American Delegate in the arduous and difficult work of the recent Conference on a Catalogue of Scientific Literature.

I am Sir,
Your obedient servant,
(Signed) DAVID J. HILL,
Assistant Secretary.

Enclosure :

From British Ambassador, December 12, 1898, with enclosures.

Washington, December 12, 1898.
THE HON. JOHN HAY,
Secretary of State.

SIR : With reference to my note of July 12th respecting the International Conference in furtherance

of the project of an International Catalogue of Scientific Literature I am instructed by Her Majesty's principal Secretary of State for Foreign Affairs to convey to the United States Government the grateful appreciation of the President and Council of the Royal Society for the cordial coöperation of the United States Delegate in the arduous and difficult work of the Conference.

I am also instructed to furnish you with four copies of the Acta of the Conference, two for the use of the United States Government, and two for that of their Delegate.

I have the honor to be
with the highest consideration

Sir :
Your obedient Servant,
(Signed) JULIAN PAUNCEFOTE.

The House of Representatives took no action in pursuance of the request of the Secretary of State, but the following amendment to the Diplomatic and Consular Bill was reported to the Senate and passed by that body.

INTERNATIONAL CONFERENCE ON A CATALOGUE OF SCIENTIFIC LITERATURE.

For the purpose of carrying out on the part of the United States the recommendation of the International Conference on a Catalogue of Scientific Literature, held in London in July, 1896, for the expense of clerk hire and other expenses incident to the work of cataloguing the scientific publications of the United States, the same to be expended under the direction of the Secretary of the Smithsonian Institution, five thousand dollars.

The Amendment was, however, disagreed to in Conference and lost.

The following petitions in behalf of the proposition were presented to the Senate :

THE PUBLIC LIBRARY OF THE CITY OF BOSTON,
Boston, Mass., January 25, 1899.
HON. GARRETT A. HOBART,
Vice-President of the United States, President of the Senate.

SIR : The trustees of the Public Library of the City of Boston understand that Congress is to be asked for an appropriation to be placed at the disposal of the Smithsonian Institution to enable that institution to render necessary service in connection with the Royal Society index of scientific publications.

The trustees beg to urge upon you the importance of this undertaking. Although it carries the name of

the Royal Society, it is in fact international ; it has been organized by representatives from the various civilized countries ; its benefits will be shared by all civilized countries, and the index itself will be the product of contributions from them. The contribution asked for is not a direct gift of money, but a special service. For this country the proper agency for such service is at present the Smithsonian Institution. This institution cannot undertake it with its ordinary funds, and requires for it a special appropriation.

The amount of this is small compared with the importance of the service to be rendered.

Full information as to the details of the undertaking and of the particular work for which the appropriation would be expended will no doubt be laid before Congress.

The trustees of this library content themselves with calling to your attention the significance of the undertaking itself, and desire to express their conviction that the benefits which will result to libraries and other learned institutions and to individual scholars throughout the United States will be a most ample return for the expenditure proposed.

Very respectfully,

THE TRUSTEES OF THE PUBLIC LIBRARY OF THE
CITY OF BOSTON :

FREDERICK O. PRINCE, *President*,
SOLOMON LINCOLN, *Vice-President*,
JOSIAH H. BENTON, JR.,
HENRY P. BOWDITCH,
JAMES DE NORMANDIE.

By order of the board.

Attest :

HERBERT PUTNAM, *Clerk*.

Mr. Platt, of New York, presented the following resolution of the Board of Trustees of the New York Public Library, Astor, Lenox and Tilden Foundations :

" WHEREAS, The honorable Secretary of State has recommended to Congress the appropriation of the sum of \$10,000, to be expended under the direction of the Smithsonian Institution, for cataloguing the current scientific literature of the United States, to form a part of an International Catalogue of Scientific Literature : and

" WHEREAS, Each of the great European nations has undertaken to catalogue in like manner its own scientific literature for the same purpose, the whole to be edited and published by a central bureau : Therefore,

" *Resolved*, That the trustees of the New York Public Library, Astor, Lenox and Tilden Foundations,

respectfully urge upon Congress the great desirability of making the appropriation requested by the honorable Secretary of State for this purpose, as the work to be done is international in character and will be for the benefit of all scientific men and of all libraries and institutions of learning in the United States."

The motion was agreed to.

Petitions were also presented by the American Library Association and the John Crerar Library of Chicago, and a strong endorsement of the project was sent to the Committee on Appropriations by the Secretary of State.

For the purpose of obtaining the advice of scientific men and persons interested, in accordance with Resolution 22 of the Conference, the following Committee was named on the part of the United States : Dr. J. S. Billings, Chairman ; Professor Simon Newcomb, Dr. Theo. N. Gill, Professor H. P. Bowditch, Dr. Robert Fletcher, Mr. Clement W. Andrews, Mr. Herbert Putnam and Dr. Cyrus Adler. This Committee requested that Harvard University, Yale University, Columbia University, the University of Pennsylvania, Princeton University, Johns Hopkins University, the University of Michigan, the University of Chicago, Leland Stanford Junior University, the American Museum of Natural History, the Academy of Natural Sciences, the American Philosophical Society, the Library of Congress, the United States Coast and Geodetic Survey, the United States Geological Survey and the United States Weather Bureau appoint committees on the subject, these committees to report to the Committee above named by April 15th.

The request was generally acceded to, and with a few exceptions reports have been received which represent the opinions of a large number of scientific men and librarians in this country.

All of these reports and various informal suggestions were considered, and a series of resolutions, together with the reports, have

been transmitted to the Secretaries of the Royal Society, with an occasional expression of opinion as to the merits of the views presented in the several reports.

The next step will be the consideration of these reports and of similar reports from other countries and the formulation of a definite plan by the Provisional International Committee.

In view of the failure of Congress to make an appropriation for carrying on the work in this country, it will be necessary should the Catalogue begin January 1, 1900, to make some special provision. It is hoped that, by the cooperation of universities and libraries in five or six of the large centers, the work can be carried on for one year, and that when the subject is next presented to Congress it will meet with more favorable consideration.

CYRUS ADLER.

SMITHSONIAN INSTITUTION.

A DOUBLE INSTRUMENT AND A DOUBLE METHOD FOR THE MEASUREMENT OF SOUND.

THE work briefly sketched here, at the request of the editor of SCIENCE, was done by the writer in the laboratory of Clark University, and grew out of the suggestion of Professor Webster, that the optical arrangement of Michelson's refractometer, combined with an accoustical method employed by Wien,* might yield a sound-measuring apparatus of great sensitiveness.

RECEIVER.

For this purpose one totally reflecting mirror of the refractometer was made very small and light, and was mounted upon a thin glass plate, which formed a portion of the walls of a spherical, Helmholtz resonator. A pure tone of the same pitch as the resonator causes the interference bands to vibrate with the same frequency. In order to render the maximum displacement

* Wied. Ann., 1889, p. 835.

visible, the fringes were made vertical, then cut down to a narrow band by a screen with a horizontal slit. This band was viewed by means of a telescope whose object glass was a small lens mounted upon the end of a tuning fork of the same frequency as the source of sound. The fork was driven electrically and the motion of the lens was perpendicular to the narrow band, so that, if the sensitive resonator plate were protected from all sound, the fringes would not be displaced, but the motion of the object glass would stretch out the narrow band into a broad band of vertical fringes. If now a tone were admitted to the resonator the fringes would be simultaneously displaced. In case of the identical agreement of both frequency and phase of the telescope fork with the forced vibration of the resonator plate (excited by the source of sound) the composition of motions would result in a similar band, but one covered with oblique fringes whose slope is a function of the intensity of the sound. Identity of phase is easily realized by making the telescope fork actuate the source of sound; but identity of phase depends upon the distance of the source of sound (as well as upon some elements involved in the mechanical construction of the source of sound, which elements cannot be varied within limits sufficiently wide to compensate for all phase differences depending on various distances of the source), and consequently this identity could be obtained only at particular settings. In a room filled with standing waves from the source, these settings can be found by moving in the three dimensions either the source of sound or receiver. But this adjustment is laborious, and this limitation renders the apparatus unsuited to general investigation. Without such adjustment the composition of the motions of the bright spots in the narrow band gives a set of overlapping ellipses, obscuring the displacement.

Accordingly the frequency of the lens fork was made slightly different from that of the source, by loading it sufficiently to obtain slow beats. Thus the phases of the one overtook those of the other very slowly, and consequently the interference bands were obtained, sloping first to the right and then after an interval to the left, the changes occurring periodically and following each other as slowly as desired. By means of a suitable eye-piece with divided circle the angle of this slope can be measured, and gives immediately a means of measurement of relative intensities.

CAMERA.

For some work the stroboscopic method of direct observation was replaced by a photographic method by which permanent records of sound disturbances were obtained and intensities determined. In this case the telescope with vibrating eye-piece was replaced by a fixed lens system which focussed a narrow band of fringes upon a sensitive film mounted upon a uniformly revolving cylinder, in a manner similar to that employed by Raps.* The cylinder was driven by a small motor, whose speed was kept constant by Lebedew's† method. Since this photographic record can be made equally well in case of irregular disturbances of the air, the instrument, with the receiving resonator removed from the sensitive plate, affords an unequalled means of studying the physical characters of a great variety of sounds and noises, such as vowel sounds and consonants, the notes of various musical instruments, the calls of birds, the cries of animals, bells, whistles, the din of the streets, the rumble of thunder, etc. The effect of the peculiar note of the sensitive plate may be eliminated by means of differential measures with plates of different natural periods.

* Wied. Ann., 1893, p. 194.

† Wied. Ann., Band 59, s. 118.

SOURCE OF TONE.

For the determination of the instrumental constants, and for fundamental researches in sound, it is essential that the source of sound be pure in tone, constant in intensity, and that its intensity be easily varied within considerable limits. It should also be portable. The following arrangement meets these requirements in a very satisfactory manner. A tuning fork of about the same pitch as the note desired was driven by an electromagnet with a current interrupted by a similar *control* fork, electrically driven by the usual method of self-interruption. The first fork was fastened vertically upon a heavy iron base, and one of its tines was connected to a circular, thin iron plate, of approximately, the same pitch as the fork, by means of a short stiff wire. This plate formed a side of a Helmholtz resonator, constructed to give the note desired and rigidly supported. The motion of the fork tine was in the direction of the wire, i. e., perpendicular to the plane of the plate, so that the vibrations of the fork were communicated to the plate; thus the air within the source resonator is thrown into forced vibrations of very nearly its own frequency. Accordingly a very small vibration of the fork causes the resonator to emit a very loud tone. Its intensity depends upon the current driving the source fork, and this current is governed by a sliding resistance and shunt. A single storage cell suffices for the loudest tones, and $\frac{1}{10}$ ampere produced a tone loud enough to be heard very distinctly all over a large lecture room (about 14x24 yards). This source was enclosed in a heavy, padded box, so that only the lip of the resonator protruded. Perfect silence could be obtained by simply corking the mouth of the resonator with a rubber stopper, so that a single and definitely located source was obtained, and one which is portable.

Care was taken that no sound should

reach the receiving resonator from the telescope-fork, for it also was carefully boxed. The box was provided with glass windows for the transmission of the beam from the refractometer, which was similarly boxed in such a way that a portion of the receiving resonator protruded and pulsations of sound acted only upon the side of the sensitive plate which faced the mouth of the resonator. The adjusting screws of the refractometer were brought outside the box. The whole was small and portable. Equal care was taken to keep all sounds from motor and cylinder from reaching the receiving resonator, and all these pieces rested upon little piers of soft rubber and tin in layers, this to prevent vibrations from being transmitted through the table and supports. Careful tests were made for immunity from such disturbances.

Results obtained thus far give promise of a high degree of constancy, and of sensitiveness greater than the human ear, *i. e.*, ability to detect both extremely faint sounds, such as escape the sense of hearing, and also the most minute differences in intensity. For this reason this instrument may prove useful in the psychological laboratory.

The limits of this sketch allow but an outline of the mathematical theory of the source, and of the receiver, by which the intensity of a tone is reduced to absolute measure. For a measure of intensity can be made independently by each, and one may be used as a check on the other.

ENERGY OF SOURCE.

The energy emitted by the source resonator in sound may be measured in a manner analogous to one employed by Rayleigh* in determining the minimal sound. The rate at which the source fork expends its energy is readily shown to be

$$-\frac{d}{dt}(E_n) = K E_n e^{-Kt_n} = K E_n \text{ per sec.},$$

* *Phil. Mag.*, 1894, p. 365.

and this energy is constantly supplied by the current driving the fork. But not all this energy is converted into sound. In fact K is composed of three distinct parts:

K_1	peculiar to the fork	alone,
K_2	" " " plate	"
K_3	" " " resonator	"

If the resonator is made very smooth within we may neglect the dissipation of energy in other forms within the resonator and say that the production of tone is due to K_3 for the system. Accordingly the energy of the tone produced is $K_3 E_c$, when E_c represents the sum of the energy of fork, plate and connection at the time. The energy of fork and connection are approximately

$$E_f = \frac{1}{4} \rho l \omega \pi^2 (2\eta)^{1/2} \text{ for fork,}$$

$$E_c = \frac{1}{8} \pi^2 M_c (2\eta)^{1/2} \text{ " connection.}$$

The energy of the plate is an infinitesimal of the second order.

Since $2\eta = A e^{-Kt}$, K can be obtained by noting the time required for the amplitude to fall one-half. The resonator plate is mounted upon a separate ring so that the resonator may be removed without disturbing the plate. Then a differential measure serves to determine K_3 . First, K is determined with resonator in place; then the resonator is removed and $K_1 + K_2$ is determined; thence

$$K_3 = K - (K_1 + K_2) = 2 \log 2 (1/t_1 - 1/t_2).$$

A galvanometer, or millivoltmeter, is interposed in the circuit containing the source forks, so that a few measures, taken through some range of intensities, suffice to calibrate the current in terms of absolute intensity at the mouth of the resonator. From this a simple assumption regarding propagation gives the intensity at any point. Since the intensity can be varied at will, this instrument alone, with the ear for receiver, can be employed for a considerable number of investigations.

ENERGY AT RECEIVER.

The energy of the tone at the mouth of the receiving resonator is proportional to the square of the amplitude of vibration of the sensitive plate. And since this plate carries one of the refractometer mirrors its amplitude can be expressed in terms of wave-lengths of monochromatic (sodium) light. In short, an expression for relative intensity will be :

$$\left(\frac{B \tan a}{w} \right)^2$$

when B is the double amplitude due to the motion of object glass, a is the slope of the fringes due to tone, and w is the width of a double fringe. This relative measure can be reduced to absolute measure in a manner differing from that employed by Wien* only in the fact that the energy of the little mirror is taken account of and the identical resonator in the identical position, but with plate of high pitch, is used to calibrate the sensitive arrangement in absolute units.

This combination of source and receiver seems exceptionally well adapted to the investigation of such problems as the variation of the intensity of sound with distance, the viscosity of the air, sound shadows, reflection of sound from various substances, refraction of sound in various media, the distribution of sound in a room, with the natural pitch and damping (echo) of a room, intensity of the minimum sound audible, test of Weber's Law,† etc.

The elaboration of the instrument has left, thus far, no opportunity for systematic research. Some results of interest have been obtained, such as tests for constancy and sensitiveness, photographs of vowel and other sounds; but these results are fragmentary, and have been of value chiefly to serve the purpose of tests, and of sug-

gestion to further improvements in means or method. In the near future some acoustical problems will be attacked in the laboratory of Clark University, and the results, as well as a fuller account of instruments and method, will be published, it is planned, jointly by Professor Webster and myself.

BENJAMIN F. SHARPE.

GREENWICH, N. Y., June, 1899.

NEW YORK STATE SCIENCE TEACHERS ASSOCIATION.

THE third annual meeting was held at the Teachers College of Columbia University, December 29 and 30, 1898, affording to the members of the Association an opportunity to attend most of the meetings of the Society of Naturalists.

Dr. Charles B. Davenport, of Harvard University, read a paper on zoology as a condition for admission to college. He favored the study of animals by the laboratory method as outlined in the Harvard requirements, and thought that too much attention was being given to dissection in most secondary schools. He encouraged the study of economic zoology in a preparatory course, leaving most of the dissection to be done in the college.

The first afternoon was devoted to the report of the Committee of Nine, by Dr. Le Roy C. Cooley, after which the Association attended the annual discussion of the Society of Naturalists on 'Advances in Methods of Teaching.' In the evening the President, Dr. Charles W. Hargitt, delivered the annual address, on 'Science and the New Education,' in which he defined the relation of science to the other elements of the modern curriculum. The address was followed by a most enjoyable reception by the Trustees of Teachers College.

The second day began with four simultaneous section meetings. Section A, Biology, in charge of Dr. Charles L. Bristol,

*Wied. Ann., 1889, p. 834.

†Fechner, 'Hauptpunkte der Psychophysik,' p. 185.

discussed three papers: Professor George F. Atkinson, on 'Entrance Requirements for the University in Botany and Zoology'; Professor James E. Peabody, on 'Physiology in the High School,' and Miss Idelette Carpenter on 'The Teaching of Botany in the Girls High School of New York.'

Section B, Earth Science, conducted by Professor Richard E. Dodge, considered papers by the Chairman; by Mr. E. W. Sampson and by Miss L. Belle Sage. Section C, Nature Study, in charge of Mr. Charles B. Scott, attracted a larger number of teachers than any other, and presented too many papers to be mentioned in detail in this report. The discussions dealt principally with the aims of nature study, the materials for study, and plans for helping teachers. An excellent report of this section appears in the February number of *New York Education* (Albany). Section D, Physics and Chemistry, conducted by Professor Albert L. Arey, discussed these sciences from the point of view of the secondary schools, the colleges and the Regents. Professor Edwin H. Hall, of Harvard University, Dr. William Hallock, Dr. Edward L. Nichols, Professor Frank Rollins, Mr. Charles N. Cobb and Professor Irving P. Bishop presented papers.

Following the Section meetings Dr. C. F. Hodge, of Clark University, spoke on 'The Active Method in Nature Study.' Mr. Arthur G. Clement read a paper on 'The Use of the Microscope in Secondary Schools.' At the last session, which was held in the American Museum of Natural History, Mr. Frank M. Chapman gave an illustrated lecture on 'The Educational Value of Bird Study.'

The Association cordially endorsed the report of the Committee of Nine, and asked a continuation of their work for another year. Resolutions were adopted in favor of one year of physical science, one of biological science and one of earth science in

all the secondary schools of the State, and steps were taken toward the recommendation of subject-matter and effective methods in each of these branches. It was also resolved "That any physical, biological or earth science which has been pursued consecutively for one full year, by the approved class-room and laboratory methods, and which has stood the approved tests for quality, should be accepted by the colleges for admission to their freshman classes."

Authority was given to a committee of five "to ascertain and report what is definitely known regarding the physiological effects of alcohol and narcotics on the human body, and to recommend suitable methods for teaching the same in the schools of this State."

The sessions were well attended and the character of the papers and discussions was a sufficient evidence of the interest that centers in the Association and its work. The Teachers College provided amply for all the wants of the visitors and made their stay in the city comfortable as well as profitable.

A complete report of the meetings will be published by the Regents and may be obtained by applying to the Secretary of the Association.

The next meeting will be held at Syracuse during the Christmas holidays.

The following officers were chosen for 1899: President, Le Roy C. Cooley, Vassar College, Poughkeepsie. Vice-President, Albert L. Arey, Rochester Free Academy, Rochester. Secretary and Treasurer, James E. Peabody, The High School, 3080 Third Avenue, New York City. Executive Council, Mr. Charles N. Cobb, Regents Office, Albany; Dr. Franklin W. Barrows, Central High School, Buffalo; Professor J. H. Comstock, Cornell University, Ithaca; Professor William Hallock, Columbia University, New York; Miss Mary E. Dann, Girls High School, Brooklyn; Professor D. L.

Bardwell, State Normal School, Cortland ; Dr. Charles W. Dodge, University of Rochester ; Principal Thomas B. Lovell, High School, Niagara Falls ; Professor, W. C. Peckham, Adelphi College, Brooklyn ; Professor J. McKeen Cattell, Columbia University, New York ; Professor John F. Woodhull, Teachers College, New York ; Professor E. R. Whitney, High School, Binghamton.

FRANKLIN W. BARROWS.

SCIENTIFIC BOOKS.

Urkunden zur Geschichte der nichteuklidischen Geometrie. Von F. ENGEL und P. STAECKEL. I. Nikolai Ivanovitsch Lobatschewski. Leipzig, B. G. Teubner. 1899. 8vo. Pp. 476.

The name of Lobachévski is inseparably connected with a scientific advance so fundamental as actually to have changed the accepted conception of the universe.

Yet his first published work and his greatest work have both remained for over sixty years inaccessible, locked up in Russian, and are now for the first time given to the world in this monumental volume by Professor Engel.

As to the precise time at which Lobachévski shook himself free from Euclid's two thousand years of authority there is still room for a most interesting doubt.

The first of the two treatises given in this book, 'On the Elements of Geometry,' was published in 1829, with this note at the foot of the first page :

"Extracted by the author himself from a paper which he read February 12, 1826, in the meeting of the Section for Physico-mathematic Sciences, with the title : 'Exposition succincte des principes de la Géométrie, etc.'"

Again, when the four equations are reached which really contain the essence of the non-Euclidean geometry, Lobachévski subjoins this note : "The equations (17) and all that follows these the author had already appended to the paper which he presented in 1826 to the Section for Physico-mathematic Sciences."

In the introduction to the second of the two treatises here given, the 'New Elements of Geometry,' the author says : "Everyone knows

that in geometry the theory of parallels has remained, even to the present day, incomplete.

"The futility of the efforts which have been made since Euclid's time during the lapse of two thousand years to perfect it awoke in me the suspicion that the ideas employed might not contain the truth sought to be demonstrated, and for whose verification, as with other natural laws, only experiments could serve, as, for example, astronomic observations.

"When, finally, I had convinced myself of the correctness of my supposition, and believed myself to have completely solved the difficult question, I wrote a paper on it in the year 1826, 'Exposition succincte des principes de la Géométrie, avec une démonstration rigoureuse du théorème des parallèles,' read February 12, 1826, in the séance of the physico-mathematic Faculty of the University of Kazan, but never printed." No part of this French manuscript has ever been found. The latter half of the title is ominous.

For centuries the world had been deluged with rigorous demonstrations of the theorem of parallels. We know that three years later Lobachévski himself proved it absolutely indemonstrable.

Yet the paper said to contain material to stop forever this twenty-centuries-old striving still was headed 'démonstration rigoureuse,' just as Saccheri's book of 1733 containing a coherent treatise on non-Euclidean geometry ended by one more pitiful proof of the parallel-postulate.

If Saccheri had lived three years longer and realized the pearl in his net, with the new meaning, he could have retained his old title : 'Euclides ab omni naevo vindicatus,' since the non-Euclidean geometry is a perfect vindication and explanation of Euclid. But Lobachévski's title is made wholly indefensible.

A new geometry, founded on the contradictory opposite of the theorem of parallels, and so proving every demonstration of that theorem fallacious, could not very well pose under Lobachévski's old title. Least said, soonest mended. He never tells what he meant by it, never tries to explain it.

Yet Engel thinks that under this two thousand years stale title, 'avec une démonstration

rigoureuse du théorème des parallèles,' "Lobatschewskij sprach es klipp und klar aus, dass das Euklidische Parallelenaxiom niemals werden bewiesen werden können, weil es unbeweisbar sei."

At the International Mathematical Congress, 1893, I maintained in his presence that Felix Klein was utterly in error where in his 'Nicht-Euklidische Geometrie,' I., p. 174, he says of the letter from Gauss to Bolyai Farkas, 1799, "In this last letter is particularly said that in the hyperbolic geometry there is a maximum for triangle-area;" and again where he says, p. 175, "There can be no doubt that Lobachévski as well as Bolyai owe to Gauss's prompting the initiative of their researches."

Klein's only answer was that his position would be sustained when the public got access to Gauss's correspondence.

Staeckel and Engel have now had complete access to these papers, and this is what Engel says, pp. 428-9: "But at all events in Gauss's letters there is nowhere a support for this tradition; at no point of these letters can be found even the slightest intimation that Gauss connected the discoveries of Lobachévski and J. Bolyai with any direct or roundabout prompting from him."

"On the contrary the letters show (see p. 432 f. and Math. Ann. 49, p. 162, Briefwechsel G. B., p. 109) that Gauss throughout recognized the independence of both, exactly as he recognized that of Schweikart, whose independence of Gauss is subject to no doubt."

"With Staeckel I am at one herein that exactly this circumstance is particularly weighty for the decision of the whole question."

The whole scientific world will breathe a sigh of relief that Klein's ungenerous Göttingen legend, mortally wounded in 1893, is in 1899 annihilated forever.

More inexplicable is Klein's bald misinterpretation of Gauss's letter of 1799 to Bolyai Farkas. I gave this letter in my Bolyai as demonstrative evidence that in 1799 Gauss was still trying to prove Euclid's the only non-contradictory system of geometry, and also the system regnant in the external space of our physical experience. The first is false; the second can never be proven.

Summing up this same letter, Engel, p. 379, instead of finding in it the hypothetical white elephant of Klein's fairy tale, gives the utmost that can be attributed to it in the following sentence: "Hier ist er also ganz nahe daran, an der Richtigkeit der Geometrie, das heisst, des Euklidischen Parallelenaxioms zweifelhaft zu werden."

Five years later, in a letter of November 25, 1804, Gauss speaks of a 'group of rocks' on which his attempts had always been wrecked, and adds: "I have, indeed, still ever the hope that those rocks sometime, and, indeed, before my death, will permit a passage. Meanwhile I have now so many other affairs on hand that at present I cannot think on it, and, believe me, I shall heartily rejoice if you forestall me and if you succeed in surmounting all obstacles." "Surely," says Engel, "that does not sound as if the authority of Euclid had diminished in power since the year 1799; on the contrary, one gets the impression that Gauss in 1804 rather stood more completely under its ban than before."

This was clearly the view of Bolyai János, whose autobiography, after quoting Gauss's letter of 1832, says: "In a previous letter Gauss writes he hopes some time to be able to circumnavigate these rocks—so then he hopes!!"

"These last words," say Staeckel and Engel in the *Mathematische Annalen*, "show a certain suspicion on the part of John against Gauss." But the mention of this earlier letter was highly natural.

János had known of it from boyhood. The joy of his triumph in solving what had baffled all the world for two thousand years was intensified by his knowing that even Gauss had tried and was hoping for the impossible.

His splendid trumpet call of glory announcing his creation of a new universe, *scientiam spatii absolute veram exhibens*, is answered how? Gauss answers that method and results coincide with his own *meditations* instituted in part since 30-35 years. But of these *meditations* Gauss had published never a word! How natural then for János to refer to his previous letter, where he still was hoping to prove Euclid's parallel postulate.

The equally complete freedom of Lobachév-

ski from the slightest idea that Gauss had ever meditated anything different from the rest of the world on the matter of parallels is demonstrated most happily.

Bartels, the teacher of Lobachévski, never saw Gauss after 1807, received at Kazan one letter from him in 1808, probably a mere friendly epistle containing nothing mathematical, and not another word during his entire stay there.

But in November, 1808, Schumacher, in Göttingen, writes in his diary that Gauss has reduced the theory of parallels to this, that if the accepted theory were not true there must be a constant *a priori* of length, 'welches absurd ist,' yet that Gauss himself considers this work not yet completed.

Thus in 1808 Gauss still vacillates. The proposition about the *a priori* given unit for length is due to Lambert, 1766, and on the supposed absurdity Legendre in 1794 had founded a pseudo-proof of the parallel postulate.

Thus until after 1808 Gauss had made no advance beyond the ordinary text books.

A most fortunate piece of personal testimony from the distinguished astronomer Otto Struve finishes the whole matter.

When at Dorpat in 1835 and 1836 Struve was attending his lectures, Bartels repeatedly spoke of Lobachévski as one of his first and most gifted scholars in Kazan.

Lobachévski had then already sent his first works on non-Euclidean geometry to Bartels, but, as Struve writes, Bartels looked upon these works 'more as interesting, ingenious speculations than as a work advancing science.'

Struve adds he does not recall that Bartels ever spoke of any accordant ideas of Gauss.

Such misconception of the import of non-Euclidean geometry was due in part to that lack of grit or slip in judgment which let Lobachévski damn this child of his genius with the name 'Imaginary Geometry.'

If Lobachévski had possessed the magnificent Magyar mettle of Bolyai János, and dared to name his creation the Science Absolute of Space, he would not have taught mathematics with ability throughout his life without making a single disciple.

His 'New Elements of Geometry,' here at last

made accessible to the world, is such a masterpiece that it remains to-day the completest and most satisfactory text-book of non-Euclidean geometry. Written at the flood of hope and confidence, with ardor still undampened, it is in his 'New Elements' preeminently that the great Russian allows free expression to his profound philosophic insight, which, on the one hand, shatters forever Kant's doctrine of our absolute *a priori* knowledge of all fundamental spatial properties, while, on the other hand, emphasizing the essential relativity of space, and the element of human construction, human creation in it.

Lobachévski's position is still, after sixty years, the necessary philosophy for science. No one has succeeded in finding any escape from its cogency. No one has gone beyond it.

Our hereditary geometry, the Euclidean, is underivable from real experience alone, and can never be proved by experience. Not only can the truth or falsity of Euclid's parallel postulate never be proved *a priori*; not even *a posteriori* can ever its truth be proved. Therefore, Euclidean geometry, in so far as Euclidean, must ever remain a creation of the human mind.

The introduction to the 'New Elements' contains a piercing critique of Legendre's attempts on the parallel-postulate.

Here at times Lobachévski almost condescends to be humorous. For example, he says: "Although Legendre designates his demonstration as completely rigorous, he, without doubt, thought otherwise, for he adds the proviso that a difficulty which one would perhaps still find can always be removed. For this he has recourse to calculations founded on the first familiar equations of rectilinear trigonometry, which it would be necessary previously to establish, and which just in this case are useless and lead to no result."

Here for the word *trigonometry* in the Russian of the 'Collected Works,' p. 222, Engel has substituted, p. 70, by some slip, the word *geometry*. Further on Lobachévski continues: "But Legendre has not noticed here that EF may possibly not meet AC. To overcome this little difficulty you have only to suppose that EF is the perpendicular from F on BD; but then

how can we conclude therefrom that $FE = AB$ and the angle $EFC = \frac{1}{2}\pi$? It is not possible to mend the false deduction, wherein Legendre's inadvertence was so gross that, without remarking this grave error, he considered his demonstration as very simple and perfectly rigorous."

Now for a specimen of Lobachévski's philosophizing: "Strictly we cognize in nature only motion, without which sense impressions are not possible. Consequently all other ideas, for example, geometric, are artificial products of our mind, since they are taken from the properties of motion; and, therefore, space in itself, for itself alone, for us does not exist.

Accordingly it can have nothing contradictory for our mind if we admit that some forces in nature follow the one, others another special geometry.

To illustrate this thought, assume, as many believe, that the attractive forces diminish because their action spreads on a sphere. In the ordinary geometry we find $4\pi r^2$ as magnitude of a sphere of radius r , whence the force must diminish in the squared ratio of the distance.

In the imaginary (sic) geometry I have found the surface of the sphere equal to

$$\pi(e^r - e^{-r})^2,$$

and possibly in such a geometry the molecular forces may follow, whose whole diversity would depend, consequently, on the number e , always very great."

How far Lobachévski was, not only from Riemann's geometry with closed finite straight line, but also from the perspective point of view where the straight is closed by having only one point at infinity, is illustrated by the following sentences of the introduction. "I consider it not necessary to analyze in detail other assumptions, too artificial or too arbitrary. Only one of them yet merits some attention—the passing over of the circle into a straight line. However, the fault is here visible beforehand in the violation of continuity, when a curve which does not cease to be closed, howsoever great it may be, transforms itself directly into the infinite straight, losing in this way an essential property.

In this regard the imaginary geometry fills in

the interval much better. In it, if we increase a circle all of whose diameters come together at a point, we finally attain to a line such that its normals approach each other indefinitely, even though they can no longer cut one another. This property, however, does not appertain to the straight, but to the curve which in my paper 'On the Elements of Geometry' I have designated as *circle-limit*."

Lobachévski anticipated in 1835 all that was said not long ago in the columns of SCIENCE on the length of a curve. For example: "In fact, however little may be the parts of a curve, they do not cease to be curves; consequently they can never be measured by the aid of a straight."

"Lagrange takes as foundation the assumption of Archimedes that on a curve one can always take two points so near that the arc between them may be considered greater than its chord, but smaller than the two tangents from its extremities. Such an assumption is actually necessary, but by it is destroyed the primitive idea of measuring curves with straights. Thus the evaluation of the length of a curve represents not at all the rectification of the curvature; but it seeks a wholly different aim—the finding of a limit which the actual measure would approach the more as this measure was made the more exact. But measuring is considered more exact the smaller the links of the chain employed. This is why in geometry one must show that the sum of tangents decreases while the sum of chords increases until the two sums differ indefinitely little from the limit both approach, which geometry assumes as length of the curve."

In the splendid treatise which follows this interesting introduction Lobachévski has given a complete coherent development and exposition of the non-Euclidean geometry. Until I visited Maros-Vásárhely it was not known that Bolyai János had actually commenced and made remarkable progress in an even greater, more masterful treatment of the whole matter. From the mass of John's papers tumbled in a big chest I singled out especially a manuscript in German entitled 'Raumlehre,' and on pointing out to Professor Bedőházi János some of the striking passages in it he promised its publication.

In SCIENCE for September 24, 1897, I mentioned these treasures as 'extended researches anticipating the discoveries of Cayley and Klein.' Engel now says of them, p. 393: "J. Bolyai had also commenced to work out a great and consecutive presentation of geometry, but what he had written down remained entombed in his papers and has never been published.

"Staeckel will before long make generally accessible so much of it as is suitable for publication, and it will then appear that J. Bolyai in his exposition set to work according to principles similar to those Lobachévski actually followed." But though Lobachévski has given his complete message to the ages, yet is perceptible a touch more masterful in even the brief two dozen pages of the young Magyar.

Through a given point to draw a parallel to a given straight; to draw to one side of an acute angle the perpendicular parallel to the other side; to square the circle—these problems would be sought in vain in the two quarto volumes of Lobachévski.

Bolyai János gives solutions of them startling in their elegance. For example (Halsted's Bolyai § 34), "Through D we may Draw DM \parallel AN in the following manner: From D drop $DB \perp AN$; from any point A of the straight AB erect $AC \perp AN$ (in DBA), and let fall $DC \perp AC$. A quadrant described from the center A in BAC, with a radius = DC, will have a point B or O in common with ray BD. In the first case the angle of parallelism manifestly is right, but in the second case it equals AOB. If, therefore, we make $BDM = AOB$, then DM will be \parallel BN."

About 100 pages of Engel's book are devoted to a life of Lobachévski, yet no word is said of his wife, his children, his family life, his home fortunes and misfortunes, nor is mentioned the biography by E. F. Letvenov (St. Petersburg, 1894, pp. 79) containing romantic pictures of these eternal interests.

GEORGE BRUCE HALSTED.

AUSTIN, TEXAS.

The Spirit of Organic Chemistry. An Introduction to the Current Literature of the Subject. By ARTHUR LACHMAN, B.S., PH.D., Professor of Chemistry in the University of Oregon. With an Introduction by PAUL C. FREEER,

M.D., PH.D., Professor of General Chemistry in the University of Michigan. New York, The Macmillan Company. 1899. Pp. xviii + 229. Price, \$1.50.

Under the above title an historical account of the development of some of the most important chapters is given. The subjects selected are among those which have exercised the minds and skill of the greatest chemists, and which are to-day before the chemical world. Problems which have been solved in a single masterly research are omitted. In the nine chapters the following subjects are treated: The constitution of rosaniline, Perkins's reaction, the constitution of benzene, the constitution of aceto-acetic ether, the uric-acid group, the constitution of the sugars, the isomerism of fumaric and maleic acids, the isomerism of the oximes, and the constitution of the diazo compounds.

The author has used excellent judgment in condensing the literature, and has presented the subject in a logical and clear manner. The account is brought up to date, even the most recent work receiving brief mention. The book is, therefore, an introduction to the chemical literature of to-day. On this account it is of special value to the student who has just mastered the text-books of organic chemistry and who desires to go farther. The mass of literature which is summed up in but 225 pages is so great and complex that it is doubtful whether the student would have the time and energy to get as clear a conception of the subject by searching through the journals as he can get by a careful study of this book. After mastering it he would be in a position to follow a paper on any of the subjects treated.

The literature of organic chemistry is so vast that there is room for such critical reviews, for, it seems to the writer, they tend to inspire rather than prevent reading. Professor Lachman's book will make the reading of the current journals easier and is, therefore, helpful. It is a contribution to chemical history and supplements Schlörlemmer's well-known "Rise and Development of Organic Chemistry."

JAMES F. NORRIS.

MASSACHUSETTS INSTITUTE
OF TECHNOLOGY.

Commercial Organic Analysis. By ALFRED H. ALLEN, F.C., F.C.S. Third edition, illustrated with revisions and addenda by the author and HENRY LEFFMANN, M.A., M.D. Volume II., Part I., Fixed oils, fats, waxes, glycerol, nitroglycerine and nitroglycerine explosives. Philadelphia, P. Blakiston's Son & Co. 1899. Pp. 387. Price, \$3.50.

The new editions of Volumes I. and IV. of this excellent work were noticed in *SCIENCE* some time ago. The present part contains only a portion of the matter originally included in the second volume, the discussion of the hydrocarbons and their immediate derivatives being reserved for the second part of the same volume. The more important additions to this part are: the bromine thermal method, methods for the determination of glycerol, acetyl number, various tests for oxidation of oils, composition and official methods for examination of dynamites and smokeless powders, degreas and cloth oils.

The standard character of the work is so well known that any detailed criticism is unnecessary. The revision has been well done and the book gives a good account of the present state of knowledge in what must be acknowledged as one of the most difficult as well as important fields of analytical chemistry.

W. A. NOYES.

BOOKS RECEIVED.

I Sogni. SANTE DE SANCTIS. Torino, Fratelli Bocca. 1899. Pp. 390.

Geometrical Drawing for Army and Navy Candidates and Public School Classes; Vol. 1., Practical Plane Geometry. EDMUND C. PLANT. London and New York, The Macmillan Company. 1899. Pp. xiv + 185.

Poems of Nature and Life. JOHN WITT RANDALL. Edited by FRANCIS ELLINGWOOD ABBOT. Boston, Ellis. 1899. Pp. 556.

The Making of Hawaii, a Study in Social Evolution. W. F. BLACKMAN. New York and London, The Macmillan Company. 1899. Pp. xii + 266.

SOCIETIES AND ACADEMIES.

THE NEW YORK ACADEMY OF SCIENCES— SECTION OF GEOLOGY AND MINERALOGY.

THE section met on May 15, 1899, Dr. A. A. Julien presiding. The following program was then offered:

1. Arthur Hollick: 'A Reconnoissance of the Elizabeth Islands, Mass.'

2. W. Goold Levison: 'Several Notes on Microscopical Attachments and Photography of Minerals.'

3. Heinrich Ries: 'Preliminary Notes on the Physical Properties of Clays.'

Another paper announced in behalf of Professor J. C. Smock, State Geologist of New Jersey, on 'Artesian Water Supply in New Jersey,' was postponed on account of sickness and absence of the author.

The following is an abstract of Dr. Hollick's paper on the Elizabeth Islands, which was illustrated by specimens, photographs, sketches and charts.

The Elizabeth Islands extend in a southwesterly direction from Wood's Holl, Mass., forming the barrier between Buzzard's Bay, on the north, and Vineyard Sound, on the south.

The principal islands are five in number, and beginning at the eastern end of the group they are known as Naushon, including Nonamesett, Uncatina, Pine Island, Buck Islands and the Weepeckets; Pasque; Nashaweena; Penikese, including Gull Island, and Cuttyhunk.

Little or nothing has been written in regard to them for the reason that each island, with the exception of Cuttyhunk, on which there are a number of separate holdings, belongs to some one individual, family or corporation; hence there is no line of public travel to or through them and no house of public entertainment, except in connection with Cuttyhunk. The trip occupied a week and was made possible through the courtesy and kindness of the owners.

Taken as a whole the islands represent a partially submerged morainal ridge, which has become separated into islands and isolated from the mainland in recent geologic times. They apparently represent a later, more northern branch of the terminal moraine, the southern or older portion of which is represented by Montauk Point, Block Island and Martha's Vineyard.

One of the most interesting discoveries was an exposure of plastic and lignitic clay, presumably Cretaceous in age, on the south side of Nonamesett. The proximity of this locality

to the mainland leads to the inference that other deposits of the same age, which have escaped erosion, may be found farther north, up the old estuaries, where theoretically the formation once extended.

The general surface features of the islands are such as are characteristic of typical morainal regions, consisting of rounded hills and corresponding depressions, many of the latter occupied by ponds or swamps.

To an inquiry by Professor Kemp, Dr. Hollick stated that only indefinite lignitic remains had been detected in the deposits, and that no ilmenite boulders had been recognized. The Chairman explained that the *Pinus rigida*, of sparse occurrence on Naushon, was the prevailing conifer along the south shore of Cape Cod to the eastward, while, on the other hand, the beech was rarely found on the Cape. The morainic chain of the Elizabeth Islands extended to the northerly part of the Cape, in Brewster, separated from the south shore by modified glacial deposits in Dennis, Harwich and Chatham.

Professor R. E. Dodge was inclined to believe that the whole aspect of the topography of these islands was that of a drowned shore line, modified by subsequent erosive action, probably not caused by easterly winds. Professor J. F. Kemp favored the view of the author, that present erosive action was mainly concerned; and Dr. Hollick pointed out that the prevailing direction of the wind was southeast, that extremely violent currents prevailed in the channels, especially during ebb-tides, that sandspits occurred only at the east end of the channels, and that, during the process of sinking and erosion, the embayments deepened, met and united, and thus the channels were cut through.

Professor Levison exhibited by the lantern six photographs of minerals, natrolite and calcite, taken by reflected light; four enlargements of photomicrographs, by reflected light, of minute groups of aragonite, pyrite, apophyllite and stilbite; a new method of showing the photographic action of the Becquerel rays on a sensitive plate, by use of a written inscription on a card, in the form of a glue-line dusted with the powdered uraninite; a simple mode of attachment of a separate foot to a microscope, in

order to render it portable; and read a note on a visit to Hubbard's Mine, Fairfield county, Connecticut, with description and analysis of apparently a new lithia mineral from that locality. The Chairman suggested that such photographic enlargements might be of great service for study of faces and even goniometric determinations on very minute crystals, where numbers of such crystals were arranged in coincident planes and proper adjustments could be made.

In the absence of Dr. Ries, an abstract of his paper was presented by Professor Kemp, with emphasis on two important conclusions: First, that the plasticity of clays was not caused by the predominance of any particular constituent, such as Kaolin, but by the physical coherence of minute surfaces; secondly, that the fusibility of clays was due, not so much to their mineral components, but to their ultimate chemical composition, and that this could be, therefore, practically improved, when necessary, by intermixture with the proper constituents.

The Academy then adjourned to October 2, 1899.

ALEXIS A. JULIEN,
Secretary of Section.

TORREY BOTANICAL CLUB, MAY 9, 1899.

THE regular program of the evening consisted of an address by Mr. Samuel Henshaw, 'Notes on the Flora of Porto Rico,' giving an account of the people, customs, climate and present conditions of that island. He exhibited numerous specimens of Porto Rican utensils and articles of household use of vegetable manufacture, including many applications of the calabash gourd, from spoons to chopping-bowls, many ways of using palm leaves, etc., etc. He referred to the immense growths of *Bougainvillea*, showing a specimen, of Crotons in the open sun, of *Fourcroya*, *Lantana*, etc. He showed many photographs, portions of large tree fern and banana trunks, a tall wooden mortar and dumbbell-shaped wooden pestle, musical instruments made from gourds and from other sources. Orchids were few, the reports of their occurrence proving to be founded chiefly on aroids and *Tradescantias*. By one coming from the North the most singular sen-

sation is experienced on finding every common weed under foot to be what would have been a greenhouse plant at home. But he heard our soldiers say: "We would rather go out and pick a dandelion once more."

EDWARD S. BURGESS,
Secretary.

THE NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY.

THE May meeting of the New York Section of the American Chemical Society was held on the 5th at the Chemists' Club, 108 West Fifty-fifth Street.

Mr. A. H. Allen, of Sheffield, England, well known as the author of the 'Commercial Organic Analysis,' was present as the Society's guest and was warmly welcomed. In response he made a short address expressing keen appreciation of his reception by the Section and his pleasure of being able to attend this meeting.

The papers of the evening were by:

1. W. S. Myers: 'On the Alcoholic Content of Some Temperance Drinks.'
2. J. H. Stebbins: 'Upon the Action of Diazo Compounds upon Thymol para-sulpho-Acids.'
3. J. H. Stebbins: 'Note upon the Reichert Figure of Butter.'
4. L. L. Van Slyke, Geneva, N. Y.: 'Some Facts and Fictions about Milk.'
5. Martin L. Griffin, Mechanicsville, N. Y.: 'Comparative Value of certain Reagents for removing Lime and Magnesia from Natural Waters for Industrial Uses.'
6. Charles F. McKenna: 'A New Laboratory Valve.'

DURAND WOODMAN,
Secretary.

DISCUSSION AND CORRESPONDENCE.

LARVAL STAGE OF THE EEL.

TO THE EDITOR OF SCIENCE: Mr. Eugene Blackford's 'Note on the Spawning Season of the Eel' in SCIENCE (p. 741-742) is interesting as well as important. As Mr. Blackford has indicated, almost "the only known instance of the taking of a sexually matured eel has been in waters of [nearly] one hundred or more fathoms in depth." Others are rare. It

is probable, however, that our east-coast eels generally spawn in water of less depth. The occurrence of an eel with well-developed eggs in water only two or three fathoms deep in May is, however, truly exceptional. The question then arises whether the eel had matured eggs 'many months later than in the Mediterranean' or earlier. I am disposed to believe that the individual noticed had wandered beyond its breeding ground and abnormally retained its eggs on account of its uncongenial environment. As Mr. Blackford also remarks about New York, "it has always been supposed that the spawning season takes place within a month or so of the" descent of the eels in November and December, and that 'the elvers (*montées*) which ascend the rivers' in the next ensuing 'early spring' are the young of those that had entered the sea a few months before. For a long time I have been of a different opinion. Inasmuch as (1) the sea-going eels do not mature their ova till the winter season, (2) the leptocephalus young are found from February to September, or later, and (3) the transitional form between the leptocephalus stage and the cylindrical stage has been found in January, it appears tolerably certain that the elvers which ascend the rivers in the early spring are the progeny of eels that descended therefrom *not later* than winter of the *penultimate* (and not last) year before.

It may be of interest to add that brief notices and figures have been published of the development of the eel in a readily accessible journal—*Nature*—for March 18, 1897 (Vol. 55, pp. 467-468), and for May 27, 1897 (Vol. 56, p. 85).

THEO. GILL.

WASHINGTON, May 26, 1899.

SCIENTIFIC NOTES AND NEWS.

AT a general meeting of the members of the Royal Institution of Great Britain on May 22d the following scientific men were elected honorary members in commemoration of the centenary of the Institution, which is being celebrated this week: Professor S. Arrhenius, (Stockholm), Professor C. Barus (Brown University), Professor H. Becquerel (Paris), Professor G. L. Ciamician (Bologna), Professor N. Egorof (St. Petersburg), Professor A. P. N.

Franchimont (Leiden), Professor A. E. Gautier (Paris), Professor H. G. Kayser (Bonn), Professor W. Korner (Milan), Mr. S. P. Langley (Washington), Professor G. Van der Mensbrugghe (Ghent), Professor A. A. Michelson (Chicago), Professor H. Moissan (Paris), Professor R. Nasini (Padua), Professor W. Nernst (Göttingen), Professor W. Ostwald (Leipzig), Dr. E. Solvay (Brussels), Professor R. H. Thurston (Cornell), Professor E. Villari (Naples), Professor J. L. G. Vielle (Paris), Dr. E. Ador (Geneva), Dr. L. Bleekrode (The Hague), Professor J. S. Ames (John Hopkins University), Professor G. F. Barker (University of Pennsylvania), Geheimrath Professor Dr. Liebreich (Berlin), and President W. L. Wilson (Washington and Lee University).

As part of the exercises of the jubilee of Professor Stokes, Cambridge University has conferred the degree of Doctor of Science on the following delegates: Albert Abraham Michelson, professor of experimental physics in the University of Chicago; Marie Alfred Cornu, member of the Institute of France, professor of experimental physics in the École Polytechnique of Paris; Jean Gaston Darboux, member of the Institute of France, professor of higher geometry in the University of Paris; Friedrich Wilhelm Georg Kohlrausch, member of the Academy of Sciences of Berlin, Director of the Physikalisch-technische Reichsanstalt, Charlottenburg; Magnus Gustaf Mittag-Leffler, professor of pure mathematics at Stockholm; Georg Hermann Quincke, professor of experimental physics in the University of Heidelberg; Woldemar Voigt, professor of mathematical physics in the University of Göttingen.

THE President of the Dover meeting of the British Association will as we have already announced, be Professor Michael Foster. The Presidents of the various Sections are to be: Mathematical and Physical Science, Professor J. H. Poynting; Chemistry, Mr. Horace T. Brown; Geology, Sir Archibald Geikie; Zoology, Mr. Adam Sedgwick; Geography, Sir John Murray; Economical Science, Mr. Henry Higgs; Mechanical Science, Sir William White; Anthropology, Mr. C. H. Read; Physiology, Mr. J. N. Langley; Botany, Sir George King. The

local committee have already collected £1,500 toward the expenses of the meeting.

THE honors conferred by Queen Victoria on her eightieth birthday included a baronetcy for Professor J. S. Burdon-Sanderson, the well-known physiologist, regius professor of medicine at Oxford University, and the K. C. B. for Professor Michael Foster, professor of physiology at Cambridge University, and to Mr. W. H. Preece, President of the Institution of Civil Engineers.

PROFESSORS WILLIAM JAMES (philosophy), J. E. Wollf (petrography and mineralogy) and W. F. Osgood (mathematics), of Harvard University, will be abroad on a leave of absence next year. Dr. Dickinson S. Miller will take the work of Professor James, and Professor James Pierpont, of Yale University, the work of Professor Osgood.

PROFESSOR S. P. THOMPSON, F.R.S., has been nominated for the presidency of the British Institution of Electrical Engineers.

WE learn from *Nature* that at the last meeting of the Midland Malacological Society, held in Mason University College, Birmingham, on May 12th, Mr. H. A. Pillsbury, of Philadelphia, and Mr. Henry Fischer, of Paris, were elected honorary members.

THE gold medal of the Paris Geographical Society has been presented to General Galliéni.

PROFESSOR C. JUDSON HERRICK, who holds the chair of biology in Denison University, has received the Cartwright Prize (\$500) of the College of Physicians and Surgeons, Columbia University.

MR. JOHN S. LORD, of Springfield, Ill., has been appointed Chief of Division in the Department of Statistics of the Census Bureau. Mr. Lord has been Chief of the Illinois State Labor Bureau and held a position in the Eleventh Census.

DR. WILLIAM Z. RIPLEY, of the Massachusetts Institute of Technology and Columbia University, has been elected a corresponding member of the Società Romana di Antropologia.

EFFORTS are being made to collect £5,000 to erect a monument on the spot in Africa where Livingstone died.

MISS ELIZABETH M. BARDWELL, professor of

astronomy in Mount Holyoke College, died on May 28th at the age of 67 years.

MR. G. F. Lyster, a well-known English engineer, has died at the age of 76 years.

THE British Association will, at its Dover meeting, not only exchange visits with the French Association, but will also entertain the Belgian Geological Society.

THE United States Weather Bureau, which was opened at Colon, Colombia, last September, has finally been closed, its site being out of the track of the hurricanes. The instruments are to be transferred to Jamaica.

KING HUMBERT opened at Como on May 20th the International Electrical Exhibition organized to celebrate the centenary of Volta.

THE Biological Survey of the Department of Agriculture has sent Mr. W. H. Osgood and Mr. L. B. Bishop to study the geographical distribution of animals in Alaska.

THE scientific expedition visiting Alaska on the invitation of Mr. Edward H. Harriman, to which we have already called attention, left Seattle on May 31st. It is expected that the expedition will return about August 1st.

THE Entomological Society of Albany has recently been organized with an initial membership of about twenty, under the following officers: Dr. E. P. Felt, President; Professor Charles S. Gager, Vice-President; Mr. Charles S. Banks, Recording Secretary; Miss Margaret F. Boynton, Corresponding Secretary; Professor H. M. Pollock, Treasurer. The headquarters of the Society will be, for the present, at the office of Dr. Felt, the State Entomologist, where the regular meetings will be held the second Friday in each month. The objects of the organization are the promotion of interest in entomological science and the furtherance of fellowship, among those interested, for their mutual benefit and enjoyment.

THE Institution of Civil Engineers, London, is holding a conference during the present week. According to the program Mr. W. H. Preece, the President, makes an address, and various engineering subjects will be taken up in seven sections. The subjects for discussion range over the whole field of engineering ser-

vice and practice, and include railways, harbors docks, canals, machinery, shipbuilding, mining and metallurgy, water works, gas works, sewerage and electricity. It is proposed that each subject be introduced by a short paper, to be read by the author and discussed by the meeting.

Nature states, in reference to the scientific commission which was appointed a short time ago by the Colonial Office and the Royal Society to investigate the mode of dissemination of malaria, with a view to devising means of preventing the terrible mortality which now takes place among Europeans resident in tropical and subtropical climates, that Dr. Patrick Manson, chief medical adviser to the Colonial Office, has made a statement to a representative of the Exchange Telephone Company. Dr. Manson states that Dr. C. W. Daniels, of the Colonial Medical Service, British Guiana (who first proceeded to Calcutta to familiarize himself with the work which had been carried on by Surgeon-Major Ross for determining the relation of mosquitoes to the dissemination of malaria), has now arrived at Blantyre, in the Central African Protectorate, where he has been joined by Dr. J. W. W. Stephens and Dr. R. S. Christophers. At Blantyre all the resources of the Protectorate will be placed at the disposal of the commissioners, who, before their return to London, will probably pay a visit to the west coast of Africa.

THE State Board of Health of Pennsylvania has passed resolutions in view of the attempt of the Health Department of Philadelphia to conceal the presence of contagious diseases in that city. As the matter is one of scientific importance from several points of view, we quote the resolutions:

Resolved, That the State Board of Health and Vital Statistics earnestly deprecates the declared intention of the Director of Public Safety of the city of Philadelphia to conceal the presence and number of cases of smallpox, or any other communicable disease in that city, and for the following reasons:

First. Attempts of this kind invariably end disastrously, defeating their own object. Rumor always magnifies danger, creating suspicion, anxiety and panic. The publication of the exact truth indicates that the authorities are vigilant, possessing full

knowledge of the facts of the case, and have control of the situation, thus engendering a sense of security and dispelling alarm.

Second. The policy of concealment prevents those living in the immediate neighborhood of infected houses, or who may desire to visit such neighborhoods, from taking necessary precautions for their own protection, and in this way facilitates the spread of the infection.

Third. This course would vitiate the vital statistics of the city and State, impairing their accuracy and value, and destroying the confidence of the national health authorities and of those of other States and cities in the trustworthiness of our returns. The latter will, therefore, hesitate to advise their citizens to visit a community which adopts the ostrich-like policy of burying its head in the sand in the presence of a danger, instead of frankly acknowledging and bravely facing it.

Resolved, That the Board, however, desires to express its belief that the danger at present existing is not of a character to excite serious apprehension, its entire confidence in the ability and intelligence of the Health Department of the city, and its assurance that the efficient measures which have been inaugurated will speedily terminate this merely localized outbreak.

ACCORDING to the London *Times* the committee which is organizing the German Antarctic expedition has decided that the expedition is to be composed of one ship only, any possible disadvantages being compensated for by greater independence and mobility. The vessel is to be built entirely of wood. The committee are confirmed in this decision by Nansen's experience with the *Fram*, and by their desire to eliminate all possible causes of error in their magnetic observations. The ship is to be laid down this autumn, and the expedition is to be ready to start in the autumn of 1901. It is to be away two years altogether. After touching at the Cape the expedition is to make for the Antarctic Continent south of the Kerguelen Islands, and there establish a scientific station at some point suitable for wintering. A pack of Siberian dogs is to be taken, and dashes will be made on sledges towards the South Pole and the south magnetic pole. Meteorological observations will also be made from a captive balloon. After the breaking-up of their winter quarters the expedition will attempt to make as complete a survey as possible of the coast

line of the Antarctic Continent. The leader of the expedition is to be Dr. von Drygalski, who conducted the German exploration of Greenland in the years 1891-93. The committee expresses great satisfaction that the English Antarctic expedition has at last been definitely decided on, and points out that the value of the two sets of meteorological observations will be greatly enhanced by their being carried on simultaneously. According to their information, the English expedition is to make the attempt to penetrate southward from the South Pacific. The meeting of the International Geographical Congress in Berlin in October will give an opportunity for deciding on the details of the scheme of cooperation.

OWING to the public improvements in the neighborhood of Parliament-street the Royal Meteorological Society has been obliged to vacate its offices in Great George-street, and find accommodation elsewhere. The Council ultimately took rooms at Prince's Mansions, 10, Victoria Street, which have been fitted up to meet the requirements of the Society. On the evening of May 16th the President, Mr. F. C. Bayard, held an 'at home' in these new rooms, which was largely attended by the Fellows. An exhibition of instruments, photographs, etc., was arranged in the various rooms, and there were also several demonstrations by the lantern.

A BLUE book has been issued by the British government, giving a report prepared by Professors Thorpe and Oliver and Dr. Cunningham on the use of phosphorus in lucifer matches. According to an abstract in *Nature* Professor Thorpe deals with the questions from the chemical standpoint, and enters into such matters as the differences between the allotropic forms of phosphorus, the composition of phosphorus fumes, their solvent action on teeth, and the composition of the various pastes, etc., used in the manufacture of matches. Full and illustrated accounts of the process of manufacture are given, both in Great Britain and in other countries, and the precautions taken to minimize the danger of the workpeople. Dr. Oliver, whose work in connection with other dangerous trades is so well known, approaches the question from the medical standpoint, and

the portion of the report for which he is responsible is clear, concise and practical. Dr. Cunningham's report contains a full account of phosphorus necrosis, and is illustrated by diagrams showing various stages of the diseases in the teeth and jaws. This condition is the most frequent and most obvious of the poisonous effects of the phosphorus; it is not by any means the only one. He also gives in full the precautions which should be adopted in all factories for combating the injurious effects of the poisonous fumes. There are various appendices which give in detail the facts upon which the main body of the report is founded. In the match industry two forms of phosphorus are used: *yellow phosphorus*, which is highly poisonous, and gives off poisonous fumes which consist mainly of low oxides of phosphorus; and *red phosphorus*, which does not fume, and is hardly poisonous even if swallowed. Then, as is well known, there are two principal varieties of matches used: 'safety matches,' which are tipped with a composition free from phosphorus; the surface on which they strike is covered with a composition of which red phosphorus forms a part. The 'strike anywhere' matches are tipped with a paste containing yellow phosphorus in a proportion which varies from 3 to 30 per cent. It is in the making of such matches only that danger arises. In regard to them the commission reports: "So far as the home consumption is concerned, it does not seem that the prohibition of the use of yellow phosphorus would involve any serious hardship, and this course has already been adopted by Denmark, and decided upon by Switzerland, care being taken at the same time to prohibit the use or importation of yellow phosphorus matches. But neither of these countries has or had any export trade to lose. The United Kingdom, Belgium, Sweden and Japan manufacture largely for export, and it is feared that immediate prohibition of yellow phosphorus would at once divert that portion of our trade to other countries, unless international agreement upon the subject was arrived at. If grave injury to the health of the workpeople were inevitable the loss of the trade might well be regarded as the smaller sacrifice of the two, but the result of the inquiry points to a different con-

clusion. With due selection of workpeople, strict medical and dental supervision, proper structural and administrative conditions, and substitution of machinery for hand labor, it seems that the dangers hitherto attending the use of yellow phosphorus can be overcome."

UNIVERSITY AND EDUCATIONAL NEWS.

MRS. JANE L. STANFORD has executed deeds conveying to Stanford University the greater part of her property.

WASHINGTON UNIVERSITY has received a further gift of \$150,000 from Mr. Samuel Cupples for the support of the department of Civil, Mechanical and Electrical Engineering and Architecture for five years, and a dormitory to cost \$100,000 from Mrs. John E. Liggett, in memory of her late husband.

MR. ANDREW CARNEGIE has given \$50,000 to the Stevens Institute, Hoboken, for the erection of an engineering laboratory.

THE quarter of a million pounds required to inaugurate the University of Birmingham has been collected. The anonymous donor who has already subscribed liberally towards the fund has offered to give £12,500 if the total amount be raised to £300,000.

MOUNT Holyoke College has received a gift of \$10,000 from James Talcott, of New York, to complete the botanical gardens and plant-houses which are now under way at the institution.

A COLLEGE of Comparative Medicine is about to be established at Harvard University. A chair of comparative pathology has been endowed by the fund given by Mr. George Fabian, and appropriations have been made from the bequest of the late Henry L. Pierce for a chair of comparative physiology and for laboratories. It is intended that the college shall perform the functions of the Pasteur Institute, of Paris, and the Jenner Institute, of London.

THE Rev. W. H. P. Faunce, pastor of the Fifth Avenue Baptist Church, New York City, has been elected President of Brown University.

PROFESSOR HENRY G. JESUP, who has held the chair of botany at Dartmouth College for twenty-two years, has resigned.

SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; J. LE CONTE, Geology; W. M. DAVIS, Physiography; HENRY F. OSBORN, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; J. McKEEN CATTELL, Psychology; DANIEL G. BRINTON, J. W. POWELL, Anthropology.

FRIDAY, JUNE 16, 1899.

CONTENTS:

<i>On the International Catalogue of Scientific Literature of the Royal Society:</i> PROFESSOR J. VICTOR CARUS.....	825
<i>Some Common Sources of Error in Recent Work on Coccids:</i> DR. C. L. MARLATT.....	835
<i>The Royal Institution</i>	838
<i>Scientific Books:—</i>	
<i>Campbell's Elements of Practical Astronomy:</i> G. C. C.	
<i>Infinitesimal Analysis:</i> DR. C. J. KEYSER.	
<i>Boosa on Defective Eyesight:</i> C. A. O. Books Received.....	842
<i>Societies and Academies:—</i>	
<i>The Biological Society of Washington:</i> DR. O. F. COOK.	
<i>The Philosophical Society of Washington:</i> E. D. PRESTON.	
<i>Section of Astronomy and Physics of the New York Academy of Sciences:</i> DR. WM. S. DAY.....	847
<i>Discussion and Correspondence:—</i>	
<i>Cerebral Light—Further Observations:</i> DR. E. W. SCRIPTURE.....	850
<i>Professor Simon Newcomb</i>	851
<i>Scientific Notes and News</i>	851
<i>University and Educational News</i>	856

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

ON THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE OF THE ROYAL SOCIETY.*

THE Royal Society of London has already demonstrated its great interest in bibliography and literature by the publication of the 'Catalogue of Scientific Papers.' It proposes to continue its efforts. In the 'Inter-

* Translated from the *Zoologische Anzeiger*, No. 566.

national Catalogue of Scientific Literature,' which it has now planned, the Society intends to correct the chief defect of the first undertaking, the absence of a subject index. As is well known, it convened an international conference, which held meetings in London from the 14th to the 17th of July, 1896. The Conference voted to request the Royal Society to appoint a committee to consider all the unsettled questions laid before it by the Conference. The report of the committee, signed by its chairman, Professor H. E. Armstrong, was issued late in March, 1898. As compared with the 'Catalogue of Scientific Papers,' the new work is (1) to be more complete, since it is to include all the literature within the fields under consideration—not alone that 'contained in certain periodicals,' and 'books of definite categories;' (2) to present the works in two methods of arrangement, (a) according to the name of the author, and (b) according to the contents of the catalogued article or book—and in the two forms, card-catalogue and book-catalogue. But it is to be (3) just as restricted as its predecessor, the 'Catalogue of Scientific Papers,' since it is to take into account only the natural sciences, together with mathematics and astronomy, as well as psychology and anthropology. Finally (4) it is to be very much more voluminous, since the title is to be repeated on cross-reference cards under catch-words taken from the contents.

It is the business of bibliography to catalogue all works appearing separately—viz: books, periodicals, publications of societies, monographs, atlases and pamphlets, whether published by dealers, by institutions or privately—with exact statement of the name of the author or authors, if known, the form, the extent (including the number of pages, and, if present, of plates, tables or other additions), the place and time of publication, and where and at what price procurable. This part of the literature, so important for the special workers in different fields, has been collected in separate works of a general nature (like that long since published by *Reuss*) or in reports on the literature of the separate branches. The custom of several societies of giving their separate papers to the dealers as soon as they were printed and of uniting these into a volume only at a later date, as well as the practice of antiquarian book dealers since the middle of the present century, of cutting up the volumes of periodicals and society publications (because treatises on separate subjects are more salable than volumes treating of a great variety of matters), resulted in the incorporation of the titles of such works in bibliographies, often, indeed, without any statement as to their source. In order to protect the special investigator from the mistake of supposing that these were independent works that had escaped his notice, it became necessary to incorporate in bibliographies the contents of periodicals with a statement of the volume and the time of publication. It was in accordance with these principles that I elaborated the *Bibliotheca Zoologica*.

It is in this way that bibliography, in a somewhat enlarged sense, it must be admitted, can and should be compiled. But the needs of scientific investigators were not fully met by this. In addition to these bibliographies arose the *Jahresberichte* on the separate sciences. It is the province of the latter

to note not only the contents of the publications under consideration, but also the scientific results contained in them. Bibliography may, indeed, meet the needs of the writers of *Jahresberichte*, first—by giving the contents of the separate works, yet this ought to be restricted to those cases where the contents refer to two or more not immediately connected subjects (*e. g.*, if, in a work on precession and nutation, the special form of a new meridian circle is described, or if a treatise on one class of animals contains communications on an entirely different class); and, secondly, by exceeding the minimum limit for the citation of scientific contributions and incorporating, for example, from periodicals, notices of only 3 or 4 lines, if these contain important or interesting new facts (*e. g.*, the discovery of a definite organ in a group of animals in which it has not hitherto been found, or the presence of a species of animal in a place where it has not been previously observed). This, however, is the utmost limit to which bibliography (*sensu latissimo*) should go.

The first objection to be raised to the plan of the Royal Society Catalogue lies in the impracticable though only partial amalgamation of bibliographic work with that of the abstracts and reviews. No. 17 (Resolution No. 6) of the Conference reads: "That, in indexing according to subject-matter, regard shall be had, not only to the title (of a paper or book), but also to the nature of the contents." According to the wording this practically corresponds to my last statement. But the undertaking planned by the Royal Society deviates from this in essential particulars, and, indeed, in a manner that is absolutely impracticable and, at least as far as regards the examples given in the Report, useless. The plan is impracticable because the matter to be indexed is subdivided far too minutely. If, for example, all the new species of animals were to be enumerated under the name o

the genus—whether in the book-catalogue alone, or on the separate cards—or even only the new genera, not only would the work be multiplied twenty-fold or a hundred-fold, but the catalogue would be so increased in size that it would be unmanageable. And, finally, the enumeration of these names without an accompanying description has only a doubtful value for the investigator. This belongs in the *Jahresberichte*. The noting of new generic names, as I give them in the Bibliography of the *Zool. Anzeiger*, is of value to working zoologists in preventing the use of names already employed. No. 13 (Resolution No. 2) is to the effect that in preparing such a catalogue “regard shall, in the first instance, be had to the requirements of *scientific investigators*.” But is it really of special value to *investigators* to have in addition to the title three references (with special indices, while the article itself remains without any index number) to an article like that of E. Wiedemann und E. Ebert: “Leuchterscheinungen in elektrodelosen gasverdünnnten Räumen unter dem Einfluss raschwechselnder elektrischer Felder?” Or will a zoologist working on Mammals, or a physiologist looking for communications on the use of separate organs, need three reference cards for de Winton’s article ‘on the existing forms of Giraffe?’ On p. 11 of the Report (under 7) it is expressly stated that “it is not proposed that it [the card or slip] should provide an abstract, in any shape or form, of the communication to which it relates.” Apart, then, from this inconsistency (for the noting of all new species and genera, and the noting of the forms referred to in the synonymy [vide *Zoology*, 35 A.], is in reality an abstract), emphasis is laid on simple bibliography. Why, then, this enormous ballast, which is neither valuable for the investigator nor of use to the librarian or the public? It is self-evident that cross-references must be made use of,

but only in so far as is demanded by the nature and form of publication and by the wording of the title.

But, besides this, one of the chief questions is: Who shall abstract this statement of contents and select the necessary catch-word (which is required to be in English!)? Will working, busy physicists, chemists, physiologists, etc., have time and inclination, after having mastered the publications required for their own work, to read through so carefully the publications in the remoter fields of their special sciences, which do not particularly interest them, as to be able to write the necessary reference cards on every chief and accessory subject treated? It will be necessary, then, to have recourse to assistants. But it can scarcely be expected that they, even though they may have a ‘literary education,’ will be so familiar with all details of the subject that they will select those really important. And even if they were so well educated as to be able to reproduce correctly, *e. g.*, the chief headings from Italian, German, French and English works, would they be familiar with the technical expressions, often so different in the different tongues, that are to be employed as catch-words? The same difficulties would be repeated, if the (moreover quite superfluous) translation of the Italian, German, etc., catch-words were to be done by the Central Committee in London.

According to Resolution No. 2, as I have said, the needs of scientific investigators were to be regarded first. But these are not precisely the same as the needs of libraries. Will the latter be met by a catalogue of the form and extent planned? Hardly! And yet an undertaking involving so great an expenditure of time and money as this ‘Catalogue’ ought to furnish libraries—a part of whose duty it is to serve as a go-between for science and the public—with other advantages than a voluminous work of reference. But that

will not be the case. The best arranged subject-catalogues cannot embrace references which may be entirely appropriate to technical scientific bibliographies, but do not belong in general reports. The library officials will be overwhelmed by the separate references to articles, a great part of which they do not possess. A survey of that which a given library possesses, and that which is still wanting, must be secured by assorting the cards, and this will require an enormous amount of work, constantly increasing with each additional cross-reference. A library catalogue cannot and ought not to give information about the contents of things which are not in the library, unless it is to increase infinitely the difficulty of determining what new acquisitions are needful. A library is not a repertory of literature. Of course, it should be able to give ample information concerning those things which it does possess; it must, therefore, introduce extensively into its catalogue cross-references, but only such as are of a bibliographic nature.

Reflection on the problems and needs of libraries and on the possibility of the general acceptance and introduction of their plans should have protected the Royal Society from another important mistake, from the limitation of their plans to the natural sciences in the broad sense. In the case of so gigantic an undertaking as the creation not only of an alphabetic authors' catalogue, but also of an alphabetically arranged subject catalogue, it is useful to limit the plan at first to the inauguration of a part of the scientific literature. But the whole plan—the general scheme—ought under all circumstances to have been extended to the whole realm of knowledge; first, in order to facilitate—even to render possible—the same arrangement of parts in the literature of other sciences; secondly, so that the necessity of uniformity might be grasped by the framers of the scheme. But the Royal

Society purposely avoids uniformity even within the limits which it has drawn. "No attempt has been made to use similar numbers in a similar way in two or more sciences [one must, therefore, learn the scheme and the signification of the characters employed for each science by itself], the only instance in which agreement is met with being in the opening section, which in most cases [therefore, not in all] includes the general bibliography of the science" [p. 10 of Report]. But how is it carried out? Let us take the first scheme of classification: *A. Pure Mathematics*. The first division contains the heading '*Bibliography*' (without number or other designation of the rubric); then follow:

"0000 Philosophy,
0010 History,
0020 Biography,
0030 Dictionaries and text-books,
0040 Pedagogy,
0050 Addresses, lectures, essays,
0060 Works on methods."

What place, what number, does Bibliography receive here? In the case of '*C. Meteorology*' history is 0020 and Bibliography 0040, in that of '*J. Geography*' Bibliography is 0400. Elsewhere the things which are grouped together under '*Pedagogy*' receive, generally, the index 0040, but under '*J. Geography*' it bears the number 0500. If, further, one compares with these '*L. Zoology*,' he finds here a Table with 297 sub-divisions (namely, 33 systematic and nine times these from various standpoints), beginning with '02 General Zoology' '(comprehensive: 0203).' The wonderful division '31' '*Pedagogic and Economic*' embraces: "Special text-books and manuals. Preservation of specimens; Museums; Zoological Gardens and Aquaria. Relations to plants, injurious insects, etc. Galls. Special products: wax, silk, honey. Animals injurious to man. *Bibliographical*,

including Historical. Biographical." Can one imagine anything less distinct, less connected, less natural? (Museums and honey, the San José scale insect and the biography of Huxley in one group!). But how is this applied? The previously mentioned article by de Winton on the forms of giraffe receives the index L0000, which, according to analogy with all the other sciences, would be 'Philosophy,' not, indeed, in relation to Mammals or any form of Ruminant, but to Zoology in general!

The chief ground of this want of uniformity and naturalness, of these inconsistencies, lies in the system of classification and indexing adopted by the Committee of the Royal Society. This is essentially an imitation of the decimal system of Melville Dewey. But, instead of simply adopting this system, developed and tested by twenty years' of work and extensive experience in numerous libraries, the Committee has thought best to employ in the separate divisions other numbers for the same rubrics, and also another sequence for the sub-divisions, as well as other and changeable significations for these. One must unqualifiedly agree with M. Ch. Richet in his derogatory and harsh judgment upon this procedure (*v. Revue scientif.*, sér. 4, T. 9, No. 24, p. 751). While M. Richet is decidedly right in pointing out with severe criticism that the Committee simply ignores previous classifications and methods of indexing, and has only aimed to produce something different from what already existed, one may go further and affirm that, from the form in which the Committee has drawn up a kind of decimal system, it is evident that the Committee either did not perceive the main advantages of the Dewey system or that it did not wish to recognize them. It adheres to the externals, but misunderstands their significance. Thus, according to Dewey, the formal index 07 in all cases refers to the method of study and its aids, such as the

establishment of collections, etc. Under 'Sociology' Dewey calls this 'Education' (307). In order not to adopt one of Dewey's expressions, the Committee introduces the term 'Pedagogic,' which in such a connection is misleading. But the way in which this is interpreted is shown by the example of the division '31' of Zoology, cited above, and by the placing of computing machines, models, etc., under separate indices coordinate with 'Pedagogy.'

The English boast of being an eminently practical people. In this case they have not shown it to be true. There is scarcely anything less practical than the 'Schedules of Classification' and the numerical indices employed in them. Equally unpractical is the method of citation of sources. In 'Chemistry' what is the meaning of 'B.,' 'Bl.,' 'Soc.?' what (under 'Crystallography') is 'ZsK.?' The catalogue ought not to be produced for chemists alone; but the power to interpret such hieroglyphics is not to be expected of other educated people. Alphabetic catalogues of the abbreviations should be furnished; and there should be two of them—one, for the use of cataloguers, arranged according to the titles of the periodicals; another, for those using the catalogue, according to the initial letters of the abbreviation. The space that is perhaps saved is not worth the cost—the constant trouble of looking up references. One may abbreviate, but only so far as is compatible with certain recognition of the source intended. But this must be given accurately. 'Mémoires des Sav. Étrang' is ambiguous. Is Paris or is Brussels meant? The cards relating to the contents of works ('secondary slips') must contain abbreviated statements; thus 'Teeth, histology of those of Notoryctes, Tomes, etc.,' is correct. But to convert the title into another form is not permissible. Thus Beddard's paper, 'Notes on the Anatomy of a Manatee (*Manatus inunguis*), lately living in the

Society's gardens,' appears on the 'secondary slip,' under the form 'Various points of anatomy of *Manatus inunguis* and *latirostris*.' Such an example misleads, resulting in inaccurate citations, and sanctions the loose manner in which, unfortunately, citations of literature are much too frequently made. Instead of adopting the most direct and natural method, there has been an attempt to introduce a certain 'Schematismus,' which is impractical, however, because it is not rigidly adhered to. But the new 'Catalogue' is to be in English, in contrast to the plans elaborated by the Office international de bibliographie in Brussels and by the Congrès international de bibliographie held at the same place in the year 1895, which the Committee of the Royal Society has regarded simply as non-existent. This use of English (ignoring of the work of others) extends even to the specification of the size of the cards (which, of course, differs from that of the cards now in use) in English inches and lines, not in the metric scale, which is more and more extensively used even in the scientific circles of England (v. Report, p. [15], 22). It is a great satisfaction that Professor W. E. Hoyle, who has attained high scientific eminence and possesses experience in bibliographic and library matters, criticises the proceedings of the Royal Society quite as harshly as M. Richet (v. his communication in *Natural Science*, Vol. IX., July, 1896, p. 43, and the addendum of the editor of the periodical, p. 48-52).

It would be going too far to go into details; certain points, however, may be of interest. Under the Division L (Zoology) 35, 'Taxonomy and Systematic,' it is expressly stated that the book-edition of the catalogue is to present a complete systematic record of the literature of the year, "similar to that which is at present carried out in the 'systematic' sections of the *Zoological Record*." Therefore, there are to be

added to the cards, with the names of new genera and species, statements as to the families and orders to which they belong, and as to the locality where they are found; valuable information about genera and species already known is also to be given. Fossil species are to be treated in the same way (notwithstanding that there is likewise an elaborated system of Paleozoology). The Book Catalogue in this respect differs from the Card Catalogue. The latter contains only the General, the Taxonomic and the Phylogenetic; it is to contain the names of new families, sub-families and other important groups, as well as synonymic remarks. The separation of the two editions—one of which is to be issued in card form, whereas the other, giving details of the new genera and species, is to be employed only in the preparation of the book-edition—is very artificial and arbitrary. The arrangement of other divisions of 'Zoology' is also extremely unnatural and wanting in comprehensiveness. Under L 11, 'Physiology,' are found in motley array: "Parthenogenesis, Pædogenesis, Dissogony, Hermaphroditism, Function of the Sense Organs, Function of Special Structures, e. g., of Glands, Environmental Effects, Regeneration, Change of Function." This is cited as an example of what in Zoology may come under the heading 'Physiology.' If one compares with this 'N Physiology,' which receives the qualification '(animal),' the latter (animal) is found to contradict the adopted classification; for the whole division is essentially human or vertebrate physiology, with everywhere additions concerning the pathological conditions of the organs and the effects of drugs, and only a few chapters, rather as appendices, on lower animals. The existence of an elaborated scheme for Physiology by Ch. Richet is passed by with the same silence as is the zoological scheme worked out by me in the *Zoologischer Anzeiger*. Whether the branches embraced

under 'Physiology'—certainly important for zoologists too—are to be contained in the Annual Report is not stated.

But Analytical Reports (*Jahresberichte*) and Bibliography are, as already emphasized, two different things, the combination of which is injurious to both. Forty or fifty years ago a single person might possibly have been able to meet the requirements of both successfully and accurately, but that is no longer possible. In the Analytical Report many things must be mentioned of which the Bibliography cannot make note.

The explanations of the other main divisions (in the Report of the Committee) nowhere state whether Analytical Reports are to be issued for them, or whether Zoology alone is thus to be provided for. It looks as though there was a desire to make use of the existing machinery of the Zoological Record, but not to the advantage of all parts of the undertaking. Moreover, for an Analytical Report a special system of registration would be more or less superfluous, especially in the form here selected, inasmuch as the systematic arrangement, together with the alphabetical, would furnish an adequate means of orientation. But, nevertheless, there is introduced a scheme of arrangement going into the minutest details and even impossibilities. What sense or purpose is there in creating a separate rubric for '*Lower Palæozoic and Upper Palæozoic Mammals and Birds*'? But how, for example, a work '*On the History of Entomology in England*' would be designated and assigned a place is not discoverable. Likewise, difficulties are encountered in attempting to index such a paper as '*On Fossil Molluscs of Sicily*.' For the letters which are, unfortunately, introduced for geographical groups give a designation, 'dh,' only for 'Italy, with Sicily and Sardinia' (Corsica is left with France), and concerning its possible further sub-division nothing is stated. There is no

explanation whatever about the significance of the *position* of the separate characters in the series constituting an index; '35,' it is true, indicates everywhere the General; and yet this is influenced by the the registration letters and by its position. 'Fossil Molluscs of England' are 'K 35, 42 de.' 'K 35, 02' is Paleozoology in general. 'L 0235 (just the reverse order) is general Zoology, while 'L 0035' is used for the names of new genera and new groups. That a system of notation should allow the possibility of its being afterwards extended to other branches of knowledge has been disregarded. As it now stands, this is excluded; for, since the natural sciences already use up as registration symbols the letters A to Q, the incorporation of other departments of knowledge appears to be practically impossible.

Thus it becomes evident how perilous it was for the Committee of the Royal Society to endeavor to discover a new system analogous to, and in imitation of, the Dewey decimal system, instead of simply adopting that. Certain modifications which, indeed, Dewey himself holds to be possible or permissible could have been adopted, if only the chief numbers and the main features of their employment had been retained. It can scarcely be maintained that combinations of letters are more easily remembered than groups of figures. It is a matter of habit, and certainly Dewey taxes the memory less, since his numbers have mutual relations, and especially since certain important groups of ideas retain throughout the whole system the same designation, and because, moreover, the figures follow a fixed sequence. It has been objected to the decimal system that it is too detailed, since already twelve-place numbers have been reached. This objection is in part well founded, in so far as the expanders of the system, almost from the beginning of their employment of it, have given an index to

every possible idea. It appears to me, therefore, that, e.g., the scheme elaborated by Richet for Physiology is not practical. There are few writings that could not be put with equal propriety in two or more places in the system of sciences. Consequently one ought to establish rules as in the framing of statutes, indicate general points of view, and not lose oneself in casuistics. But the going into details is carried further in parts of some other systems of classification than in Dewey's. Thus, in the Schema des Realkatalogs der Kgl., Universitätsbibliothek zu Halle a.S., 'Eschatology is designated by *Ig* VI. g. F. a. to *Ig* VI. g. F. 1, polemics on eschatologic subjects in the *preceding* division by *Ij* IV. 6. $\tau\lambda\chi$ o *Ij* IV. 6. $\lambda\tau\tau$. Dewey employs for these the indices 236 and 237 with the divisions 236. 1-9 and 237. 1-7. Hartwig devotes about 800 alphabetically arranged catch-words to Roman Law, 138 to Feudal Law and 91 to Commercial Law, Maritime Law, etc. Which classification goes the further, and which symbol is the easier to remember?

* * * * *

By placing side by side the method of arrangement and indexing of the Halle Catalogue, the Dewey system and the recommendation of the Royal Society in a special case, the character of each is recognized.

dations of the Royal Society, the indexing of the literature of these sciences does, indeed, need to be altered in the direction of the decimal system. But examples from other branches of science were cited above which prove not only the applicability, but the great usefulness, of the Dewey system. The main disadvantage of the Hartwig plan lies in this, that the schedules have been elaborated separately and without regard to one another. They have, in part, been drawn up by able specialists, and may, indeed, be excellent as such, but are not, from the library point of view, suitable. The Committee of the Royal Society desired to avoid all analogy with the Dewey system, and, instead of adopting the simple and already existing system that had proved its usefulness, the Committee has created a system which is impracticable because illogical and artificial.

It is, however, not my purpose to especially recommend here the Dewey decimal system. The aim of every bibliographic system of classification is not so much to produce a scientific system carried out to the last details as to present a scheme according to which the writings of all periods can be arranged in a comprehensive and easily recognizable way. The plan must, therefore, be kept so flexible that, on the one hand, any desired amount of space may be

HALLE CATALOGUE.	DEWEY.	ROYAL SOCIETY.
Fauna of Naples Sc. II. 26. N (capel)	591. (457)	L 0227, dh(i. e. Italy)
Paleontology " Sa. I. 8. C. N (capel)	560. (457)	K 35, dh(i. e. Italy)
Mollusks " Sc. III. 9. B. a. (. .)	594. (457)	L 4227, dh(i. e. Italy)
Fossil " { Sa. IV. 3. B. f. (Sa. I. 8. C. ?)	564. (457)	K 3542, dh(i. e. Italy)
Tertiary " " ? ?	564. (t : 457)	K 7542, dh(i. e. Italy)
Fishes " " Sc. III. 13. C. (?)	597. (457)	L 1427, dh(i. e. Italy)
Fossil " " Sa. IV. 3. B. i. β (?)	567. (457)	K 35, 14. dh(i. e. Italy)

It is the opinion of many that the Dewey system is best adapted to the Natural Sciences. According to the preceding examples from the Halle Catalogue and the recommen-

easily had for every new branch of a science that may arise, and that, on the other, it can be adopted without difficulty to every requirement of the scientific worker who

needs a convenient survey of the literature in question, as well as to the peculiarities of libraries, whether large or small, public or private. There is no doubt that, sooner or later, some system like Dewey's must be adopted; in the interest of unity it is to be desired and hoped that it will be Dewey's system itself. That the Committee of the Royal Society has come to an analogous system is significant. What was said against Dewey's system by some persons at the London Conference in July, 1896, can only be regarded as having resulted from a misconception of it. It was said, *e. g.*, that it would be difficult with the decimal system to introduce new discoveries in Physics; but I should like to ask with what other system this would be easier without alteration of the scheme itself? No part of science is tied down by it, is rigidly hemmed in, firmly restricted by it [certainly not more firmly than by other systems, in which there is in certain sciences such an unlimited extension of sub-divisions (compare Roman Law, Dogmatics, etc., of the Halle Catalogue)]. On the contrary, the decimal system is the most elastic and adaptable that can be imagined, since it everywhere presents the possibility of making additions and extensions; it even lends itself, under certain conditions, to the introduction of modifications to suit the needs of the individual investigator or of special libraries. The system of the Committee of the Royal Society, on the contrary, is the most rigid and inelastic of all. Let one attempt to make an intercalation into Zoology, for example! Everything is, indeed, tied down, but not in the desirable sense that the same thing always bears the same number. Further, it has been said, that it is a very weak side of the decimal system that numbers 1, 2, etc., have to serve at the same time for a *general* system of science and as the tokens of the *separate* books. But this is not the case. Nowhere has

this been said, either by Dewey himself or by any of his followers. The separate numbers can, and are intended to, give nothing further than the rubrics into which the separate writings are to be grouped, exactly as do the combinations of letters and figures in the Halle Catalogue. Hand-books of Zoology are 590.2 according to Dewey, Sc. II. 1, according to Hartwig; but the arrangement and designation of the numerous works belonging in this category must, of course, be carried out, according to some other fixed method conformable to the custom prevailing in each individual library, just as in the case of monographs, etc., it is left to each library and to each private person to arrange the writings bearing the same indices according to pleasure. For a general bibliography, in book form or in cards (slips), this question does not arise at all, since in these cases each user and each library is at liberty to arrange the cards according to preference.

The procedure of the Committee of the Royal Society as regards the introduction of the system of classification and indexing drawn up by them leaves a singular impression. After the question of classification had been designated in the words used by Professor Armstrong at the opening of the Congress in July, 1896, as a burning one, and after the agreement of the aims of the Royal Society with those of the Congrès international de bibliographie in Brussels (1895) had been mentioned, it would have been of the greatest value to all who are interested in the further development of this international undertaking if the Committee had stated, even in the briefest manner, what position their undertaking (in imitation of that of Brussels) was intended to assume toward this model, which pursued absolutely the same object and was already in active operation. For, although the Royal Society limits itself to the Natural Sciences, the idea, the plan is identical in

both. Moreover, after the Dewey system had been thoroughly discussed in the deliberations concerning 'Resolution 17'—although this resulted in the cancellation of the words relating to this system and in the adoption of a wording which designates as unacceptable all recently recommended systems of classification and transfers the elaboration of a new system to the Committee of Organization—it would have been appropriate for the Committee, inasmuch as it was pledged to give a 'Report' on the work entrusted to it, to have explained how it came to construct a system essentially in imitation of Dewey's, and differing from this only by its unsuitableness and inconsistency. There should also have been given an explanation to serve in using it. Finally, it might reasonably have been expected that the Committee of the Royal Society would have had knowledge of the existence of a Committee of the British Association, which, appointed for zoological bibliography, might perhaps have had influence upon the determinations of the Royal Society's Committee of Zoology, in view of the exceptional position which this Committee assumes. Instead of this, the paper called 'Report of the Committee, etc.,' gives the incomplete sketch of a system of classification and indexing devised by the Committee, which completely ignores all similar previous labors and all that had been formerly accomplished in the direction of this great undertaking, all of which, taken in connection with the report of the Conference of July, 1896, seems almost a betrayal of trust.

The particulars of the organization of the whole machinery cannot be gone into here. However, it is necessary to give warning on two points—against the far too great centralization, by which all titles are to be sent to the Central Bureau in London, where they are to be revised by suitable experts; and against too great confidence in the 'Re-

gional Bureaux.' In regard to the first point, should a certain uniformity of execution appear to be secured, nevertheless it must be pointed out that it is quite inconceivable how the 'expert,' without having the works themselves before him, could make use of the subject cards and cross-reference cards (compare the examples cited above). So far as regards the activity of the Regional Bureaux, I will call attention to only one fact. In the year 1895 the Société Zoologique de France formed an organization elaborated according to a definite plan for the purpose of securing the most complete collection of the zoological bibliography of France possible, with committees and sub-committees, all represented by experts and men zealous in the cause. And what has this organization accomplished? Next to nothing! The chief part of the labor will in the present case also be left to that individual industry which, without continually meditating on 'Organization,' accomplishes the real work.

The subscription to all departments amounts to £66 (\$330.00); that of the separate sciences from £4 5s. 0d. to £8 5s. 0d. (\$21.25 to \$41.25). Zoology belongs to the most voluminous, and will, therefore, demand the last-named price. These calculations are, of course, only preliminary, and, so far as regards Zoology, for example, rest on total absence of knowledge of the subject. 'Experts' have estimated the number of zoological articles (including the whole of Anatomy!) at 5,000. I have catalogued yearly during the last three years, *without* Anatomy and with omissions unfortunately not wholly avoidable, about 8,000 zoological titles. If one reckons for Anatomy only half as many additional titles, these two branches furnish nearly one-third of the 40,000 estimated as the yearly number for all the sciences. If this is compared with the scheme of classification in Zoology, Paleontology, Physiology, etc., there is in-

contestable evidence that it was the intention to produce in this something which, with sovereign disdain for all that now exists, was to flow forth from the Royal Society's well of wisdom. But the Royal Society has not thereby erected a *monumentum aere perennius*, for if the plan should actually be carried out—from which sad result may the good fates spare science—it is unquestionable that in a very short time the whole scheme, together with numbers and everything else, will have to be changed. However thankfully the news might be received that a body like the Royal Society—to whose esteemed position in the scientific world so general a participation in this plan is to be attributed—finds itself impelled to continue the plan of a bibliographic repertory conceived by the 'Office international bibliographique de Bruxelles,' still the question must be raised: Does the uncertain and precarious condition of this undertaking, calculated entirely upon English conditions, warrant the granting of the great cost of its cumbersome organization from the public means?

J. VICTOR CARUS.

LEIPZIG, UNIVERSITY.

SOME COMMON SOURCES OF ERROR IN RECENT WORK ON COCCIDÆ.

No group of insects has excited more interest nor attracted more new students perhaps in the last few years than the scale insects, or Coccidæ. Entomological magazines, and, in fact, journals of all sorts and descriptions, and in the most unexpected and unusual quarters, have been heavily charged with literature of new species, sub-species, etc. The great number of such new species has struck the attention even of non-workers in this group, and particularly has the designation of an astonishing percentage of sub-species, physiological species, varieties, etc., been calculated to arouse the gravest suspicion as to the re-

liability of the work done and the validity of the forms characterized, especially when the characters on which the new species, sub-species, etc., are based are at all carefully investigated. That with all the enthusiasm manifested in working up new material and describing new forms many good species are found and characterized cannot be doubted, and it is, therefore, the more to be regretted that the authors responsible for much good work have been led by a surplus of zeal to be guilty also of much that must be a positive detriment to the knowledge of this group of insects. For the benefit of future students, and with the intention merely to bring about, if possible, a much needed reform in the interest of the scientific value of the work done, it may not be out of place to call attention to some of the common sources of error and questionable work. The criticisms to follow apply more particularly to the scale insects belonging to the Diaspinæ, with which the writer is most familiar, and especially to the genus *Aspidiotus* in its old and broader sense.

In the first place, it does not seem to have been sufficiently impressed on most writers that the scale covering, though an important adjunct of the insect, is not the insect itself, and still less the extraneous matter, such as sooty mold, epidermis of bark or leaf, etc., with which the scale may be covered. Many of the Diaspinæ—in fact, almost any of them—at times may assume a slight or marked so-called 'mining' habit. In other words, the female insect in revolving from side to side in the formation of the covering scale, and in making additions to it, is very apt, with her flat chitinous lobes, to cut under the superficial and more or less loosened layers of the bark, with its covering of mold or other extraneous matter, and this loosened material slides up over the scale and adheres closely to it, much modifying and changing its color and

appearance. This mining habit varies, of course, with the plant, being less on perfectly smooth bark, and much more prominent on bark that is rough or fibrous, or on older wood. The same mining habit is exhibited in scales occurring on leaves where the epidermal growth or any sooty mold, or other foreign matter, is lifted and covers the scale in the same way. Several species or sub-species of scale insects have been established on accidental variations of this character, as, for example, *Chionaspis furfurus*, var. *fulvus* King. Examples of the type of this species sent to the Department of Agriculture exhibit many scales which show none of the epidermal coverings, while others, owing to the character of the adjacent bark, are covered more or less completely by the outer layer of the bark of the plant. On this basis any scale insect almost may be split up into two or three species or varieties. The careful study of the scale in its relation to its situation on bark or leaf made by the writer has shown that the majority of the species in the Diaspinæ occasionally or frequently present epidermal or extraneous coverings.

The scale varies also in shape as influenced by the nature of its surrounding conditions. The exuviae is often shifted, or apparently so, by obstructions, such as veins or inequalities of the surface or the proximity of other scale insects. A convex scale becomes flattened when the insect occurs beneath the sheaths of the leaves, as on palms or bananas.

Color also varies very notably, being influenced undoubtedly by climatic conditions, dryness or humidity, the presence of mold or other fungi. The food of the insect on different plants undoubtedly also affects the character of the excrements. The effect of weather and age in bleaching or otherwise changing the appearance of the scale is often notable. The characteristic appearance of the scale varies im-

mensely in proportion as it has free room for growth or is crowded or massed together densely on the bark or leaves. The San José scale, growing in scattered numbers here and there on the terminal twigs, bears no resemblance whatever to the crowded masses on old, badly infested wood. The same is true of almost any other scale insect.

The covering scale, therefore, cannot be taken as a criterion of very great value in the separation of species, and by itself is almost without value. The specific characters must be found in the insect itself, the scale covering furnishing indications only of a rough sort. The describer of new species who fails to notice the importance of these sources of error, and sees a species, a sub-species, a physiological species or a variety, in every such accidental difference, greatly retards rather than advances the knowledge of this group of insects. It would be just as legitimate to describe as a new species an insect found on the under side of a leaf, as opposed to an insect found on the upper side, as to designate as new a species because a little extraneous matter is adhering to its scale covering, or to describe men as distinct species because they wear different colored coats.

When the insect itself comes to be examined, other sources of error present themselves. For example, the question of the maturity or adulthood of the specimens under study arises, and also the problem of individual variation. In the determination of material it is, as a rule, absolutely necessary to have the adult female insect. In the Diaspinæ, for example, the full grown second stage of the female is often nearly as large as the third or last stage, if not larger in some instances, and yet the difference in the structural characters of the two stages is very great. As an example of a description of a new species from a failure to recognize the maturity of the specimens, Cockerell's so-called variety

lateralis of Newstead's *diffinis* may be cited, *lateralis* merely representing the immature stage of Comstock's *cydoniæ*.

In the matter of individual variation this is just as notable in scale insects as in man or other animals. The two halves of the anal plate of a female Diaspine are never exactly alike, and often vary within quite wide limits. In different individuals from the same colony such variations are still greater. Fortunately, however, the characters of real value in this group of insects are much more constant than one who had not studied the subject would suppose, even in the case of material representing the same species from widely separated quarters of the world, and on totally dissimilar food plants. In the Diaspinæ, perhaps more markedly than in most other groups of insect, the specific characters are sharply and satisfactorily defined, and, hence, the less excuse for the cumbering and befogging of the literature which has resulted from careless, hasty and thoughtless work.

Minute differences in the pores or glands and appendages, or in the lengths of the joints of antennæ or legs, are usually individual and would often make two species of the same specimen if the latter were cut in half in the line of the main axis of the body. To return to an illustration already employed, one might as well describe men as distinct because they have Roman or Greek noses or short or long chins.

In other groups than the Diaspinæ I cannot speak from careful personal study, but I have the gravest doubts of the value of descriptions based on slight variation in the lengths of the joints of legs and antennæ, all of which must be subject, within specific limits, to variation with the age of the specimens and with its condition as to abundance or scarcity of nourishment. In this connection I cannot do better than quote the views expressed relative to the group Lecaninæ, by Mr. Theo. Pergande,

in a recent letter to a correspondent, views in which I heartily concur. He says:

"With regard to the difference in length of one or the other of the antennal joints, * * * * * I will say that it is simply individual variation; even in the same specimens the comparative length of either of the joints of both antennæ varies frequently, more or less. There is generally, also, a more or less perceptible variation in size, color and shape, in the same species, dependent in a measure on the food plant on which it may have established itself, and also on the locality. Old specimens, which have attained their full growth and have died a natural death, are generally darker, if prepared for the microscope, than younger individuals of the same stage, and with all the pores of the derm much more distinct. As to the shape of the individual scales and their sculpturing I find in our material of typical specimens of *Lec. armeniacum* the same variations as those mentioned * * * * * To consider every slight variation of specific value would lead to endless species which nobody would be able to recognize, and which would cause endless trouble in the study of this most difficult group of scale insects."

The writer trusts that the foregoing criticisms will be taken in the kindest spirit, as they are intended, and he does not wish it to be thought, for an instant, that he fails to recognize the learning and enthusiasm shown by the prominent workers in the Coccidæ, by no means all of whom have been equally guilty, and whose work in the main has been most excellent, and commands the heartiest approval, but, having experienced the great difficulty and labor necessary to discover and correct errors arising from the conditions criticised, the need of calling attention to them seems imperative.

C. L. MARLATT.

DEPARTMENT OF AGRICULTURE,
WASHINGTON, D. C.

THE ROYAL INSTITUTION.

THE celebration of the Centenary of the Royal Institution, London, which took place last week, is an event of interest and importance to scientific men, emphasized to us, perhaps, by the fact that the founder of the Institution was an American. It is a somewhat curious fact that the Smithsonian Institution should have been founded by an Englishman and the Royal Institution by an American. There has not been time for an account of the exercises in connection with the celebration to reach us, but according to the program they were to include a lecture by Lord Rayleigh on the physical work of the Institution during its hundred years' existence and a lecture by Professor Dewar on its chemical work. The attendance of a large number of foreign delegates had been assured. In the meanwhile we take from the *London Times* the following facts regarding the history and scope of the Institution.

It was founded by Sir Benjamin Thompson, or, as he preferred to call himself, Count Rumford in the Holy Roman Empire, and was an offshoot or extension of a Society for Bettering the Condition and Increasing the Comforts of the Poor, formed in 1796, according to the proposals of that somewhat eccentric genius. His ideas on the matter were formally submitted to a select committee of that Society, which reported in their favor on February 1, 1799. The next step was to circulate a definite outline of the scheme among people who were thought likely to subscribe to the undertaking, and so successful was their appeal to the public that 58 of the 'most respectable names' were obtained in a few weeks. On March 7th these original subscribers of 50 guineas each met at the house of Sir Joseph Banks, then President of the Royal Society, and elected a committee of managers, who were desired to take preparatory measures for opening the Institu-

tion, and in particular to solicit the King for the grant of a royal charter, which was obtained early the next year. Less than two months later the purchase was ordered of Mr. Mellish's house in Albemarle Street, and on June 5th the managers held their first meeting on the premises, which have ever since remained the home of the Royal Institution.

This, as may easily be inferred from the circumstances of its origin, was in the conception of Rumford a very different style of place from what it subsequently became. It was, in fact, nothing but a glorified mechanics' institute, its objects being, as defined in his proposals, the speedy and general diffusion of the knowledge of all new and useful improvements, and teaching the application of scientific discoveries to the improvement of arts and manufactures and to the increase of domestic comfort and convenience. The first was to be attained by the public exhibition, preferably in actual operation, of useful inventions applicable to the common purposes of life. A perusal of the detailed measures by which this end was to be achieved almost makes the reader suspect that in the Count's view salvation was to come by cooking. His list of the things to be shown in the repositories, indeed, includes models of 'that most curious and most useful machine, the steam engine,' of ventilators, lime-kilns, spinning wheels and looms, agricultural implements, bridges of various construction, etc., but the place of honor is given to stoves of all sorts and to the 'most perfect models of the full size' of kitchens and utensils suitable for a cottage, a farmhouse and the family of a gentleman of fortune, respectively. The Institution, too, had not been in existence for a year when a good cook was engaged for the "improvement of culinary advancement, one object and not the least important for the Royal Institution," while another of Rumford's

pet projects was the establishment of a dining-room in the house where experimental dinners could be ordered, to test the merit of any new method of cooking or any new dish that may be proposed. To attain the second of the primary objects of the Institution, Rumford proposed to fit up a lecture room for philosophical lectures and experiments and to provide a complete laboratory and philosophical apparatus for making chemical and other experiments. Only men of the first eminence in science were to be invited to "officiate in the most important and distinguished situation of lecturers," and, to judge from the prospectus, they were to confine themselves to the most severely practical applications of science.

For the first two or three years Rumford devoted all his energy to the realization of his ideas, and it is evident enough that during that time he was the ruling spirit of the Institution. The first part of his scheme to be brought into operation was the course of philosophical lectures. These were begun in March, 1800, Dr. Garnett being the first professor. For a time a temporary lecture-room was used, but it was not long before the theatre, built from the designs of Webster, was brought into occupation. This room, which is singularly successful in its acoustic properties, remains substantially unaltered at the present day, the chief structural changes being the abolition of a stone staircase that led directly from the upper gallery to the street, and the improved exit, which was finished only a month or two ago. The only other important event in the first year of the Institution's existence was the appointment of 14 committees for the purpose of specific scientific investigations; but that the managers had not the least idea of promoting what we should now call original research in pure science is obvious from the subjects into which they were to inquire. Rumford's hand is plainly

discernible in the list, which includes bread, soup, cottages, stoves, household furniture, food for cattle, mortar and cement, fireballs and combustible cakes, etc. In the next two years still greater progress was made. The chemical laboratory was brought into use, and a director, operator and assistant were appointed; the workshops, in which models of new and useful inventions were to be constructed and sold at reasonable prices to subscribers and professors, were finished and provided with the best tools obtainable; a number of skilled mechanics were engaged, and arrangements were made for the reception of ingenious and well-behaved young men, who were to be boarded in the house, working in the workshops by day and in the evening attending classes in drawing, practical geometry and mathematics, under the direction of the clerk of the works (Mr. Webster).

But in 1802 a change began to make itself felt. Doubtless the circumstances that personal reasons caused Rumford to leave England and relinquish the superintendence of the Institution was not without influence, but the main factor was want of money. Rumford was perhaps justified in writing early in 1801 that the Institution was 'not only the fashion, but the rage'; but in 1802 the case was certainly different. In 1799 the income was £6,379 and in 1800 £11,047, but in 1801 it fell to £3,474 and in 1802 to £2,999, while at the same time the expenses were increasing. In short, the state of affairs became so bad that the idea was seriously discussed of closing the place and selling off its property to pay its debts. Luckily, however, it was saved, and the management passed into the hands of men stigmatized by Sir Joseph Banks as 'the enemy' and 'the profane,' which was, perhaps, his way of saying that they possessed some businesslike instincts. Quietly dropping the kitchens, the models, the workshops and the school for mechanics, in

which Rumford's interest had centered, they determined to carry on the scientific establishment and to get money for so doing by giving 'fashion to science.' This policy may not have been magnificent, but it was successful, and has resulted in securing to the Royal Institution a place in the history of scientific progress which all the patent stoves and roasters in the world would never have assured. Nor, after all, was there anything very dreadful about it. The private patron of science or art is not despised because his liberality has afforded some struggling genius the opportunity of using his talents; why, then, should an institution have been abused because it set itself to organize the public into a sort of collective patron?

The domestic record of the Royal Institution from the time when, in Davy's words, it definitely took the "form of a body for promoting experimental science and for diffusing every species of philosophical knowledge" contains few events of surpassing interest. Financial crises have been not infrequent, and sometimes acute, but have never proved fatal. Increased prosperity was hoped for as a result of the modification of its constitution by Act of Parliament in 1810, but its first endowment, some 23 years later, was none the less welcome. This consisted of a sum of £10,000 from John Fuller, and rumor says that it was a token of gratitude because the lecture theatre of the Institution was the only place where he could overcome the insomnia from which he habitually suffered. With two-thirds of the money professorships of chemistry and physiology were to be endowed, while the remaining portion went to form an accumulating fund, the interest on which, when the capital amounted to £10,000, was to be applied to the general purposes of the Institution. Since then it has received many legacies and donations. Money left by Mr. Alfred Davis in 1870

enabled the chemical laboratory to be rebuilt in accordance with modern requirements; in 1892 Mr. T. G. Hodgkins, of Setauket, Long Island, gave \$100,000 for the 'investigation of the relations and correlations existing between man and his Creator'; and in 1896 Dr. Ludwig Mond founded and endowed the Davy-Faraday Research Laboratory, which is contiguous to the Royal Institution and under the superintendence of its managers. This is specially interesting as being in great measure the realization of a scheme which the Institution all but adopted more than half a century before. In 1843 a proposal was made to establish on its premises a school of chemistry, not only to give instruction to students, but to provide a place where original research could be carried on by skilled workers. The scheme met with cordial approval from Faraday and the managers of the Institution, and they only abandoned it because they were reluctantly driven to the conclusion that the accommodation was not sufficient to carry it out properly. Since that time schools of chemistry have been started in abundance, but no place designed exclusively for the prosecution of independent research existed in England until Dr. Mond's liberality provided this laboratory, which is open to qualified workers without distinction of sex or nationality.

The real history of the Royal Institution is the history of the discoveries made by the distinguished men who have worked in its laboratories, and to write that in full, at least for the early part of this century, would be little less than writing the history of scientific progress in England. The Institution had the good fortune to secure among its first professors three of the greatest natural philosophers this century has known. The first, Thomas Young, was a man of the most remarkable and varied attainments, but, perhaps, his best title to fame is that he was one of the prime found-

ers of the wave theory of light, which plays so important a part in modern physics. It was left to later generations to appreciate his merits in this respect and to discover that he had anticipated many points for which Fresnel was given the credit. Sir Humphry Davy's tenure of the professorship was nearly coextensive with his scientific life. Engaged in 1801, he immediately proved himself not only a lecturer of singular charm, but a most skilful and prolific investigator. His most far-reaching researches were probably those on the chemical agencies of electricity, for it was in the course of them that he decomposed the alkalis by a strong electrical current, thus not only discovering the metals sodium and potassium, but laying the foundations of electrolytical chemistry, a science whose industrial applications are now becoming more numerous and important every day. In addition, he made many researches in pure chemistry, and his work in the philosophy of flame led to the famous invention of the miner's safety lamp. The third of this triumvirate, Michael Faraday, entered the service of the Institution as assistant in the laboratory and rose to be its chief ornament and support. His scientific output during the 50 years in which he labored is quite unequalled for range and quality, including, as it does, researches in alloys, new organic compounds, optical glass, the liquefaction of gases, regelation, the action of metals on light, magnetism and diamagnetism, the magnetization of light, and the induction of electrical currents. The place of honor must undoubtedly be assigned to his work in the last department, not only because of its enormous theoretical significance, but also on account of the practical results of which it has been the starting point; it forms the foundation of the huge and increasing fabric of modern electrical engineering.

Another distinguished name in the annals

of the Royal Institution is that of John Tyndall, who for 34 years maintained the traditions of the place as a brilliant lecturer and experimentalist. His researches were numerous and varied, the main ones relating to heat, to sound and to the behavior of small particles, such as compose dust, whether of living or dead matter. Of the first the difficult investigation of the absorption by gaseous bodies of invisible radiation is the most important, but his book on 'Heat considered as a Mode of Motion' is a classic which shows to advantage his splendid power of popular scientific exposition. In sound some of his most interesting work, that on the laws governing the audibility of foghorns and other signals in thick weather, was done as scientific adviser to the Trinity Board, a position in which he succeeded his friend and colleague Faraday, while his inquiries on atmospheric dust yielded results of great value alike to the physicist and the biologist. Tyndall was succeeded, both at the Royal Institution and the Trinity House, by Lord Rayleigh, who is universally recognized as one of the ablest mathematical physicists now living. Doubtless he is best known popularly in connection with the discovery of argon, but, in fact, his scientific reputation rests upon investigations of the most abstruse and difficult kind and upon practical achievements, among which the isolation of a new gas takes a secondary place. Of the men who followed Faraday in the chair of chemistry all are still at work. The first, Sir Edward Franklin, perhaps, in strictness should not be called a successor of Faraday, since he never held the Fullerian professorship, which was bestowed on Faraday for life, but he was appointed professor of chemistry when the latter's failing health obliged him to give up lecturing, and in the laboratory of the Royal Institution he carried out some of those researches on organo-metallic compounds which stamped him as one of the

most remarkable experimentalists of the time. The next two Fullerian professors were Dr. Odling and Dr. Gladstone, and the fourth was Professor Dewar, the present occupier of the chair, who was appointed in 1877. Continuing the work initiated by Faraday on the liquefaction of gases, he has succeeded in proving by experiment that, as indicated by theory, there is no such thing as a 'permanent gas;' for, since his recent liquefaction of fluorine, helium and hydrogen, no known gas remains that has not been reduced to the liquid state. His work has opened up an entirely fresh field of physical research, and, rich as the first results have been so far, they are in all probability only small in comparison with those which will be obtained by further investigation of the properties of matter near the zero of absolute temperature.

The Institution has undoubtedly been fortunate in the professors who have worked in its laboratories. But even genius cannot do much without opportunity, and, therefore, some of the credit is deserved by the long succession of officers and members of the Committee of Managers, who have for a hundred years looked after its business affairs and guided it safely through many vicissitudes, not only without fee or emolument, but at the expense of much time and not infrequently of much money. In this connection it is interesting to note that the presidency almost seems to have become an hereditary appanage of the Dukes of Northumberland, for, with the exception of the years between 1865 and 1873, when it was held by Sir Henry Holland, it has been in their hands continuously since 1842. Mention, too, must be made of what the members themselves have done. Over and above their regular subscriptions, they, with their friends, have contributed since 1863 something like £13,000 to the fund for the promotion of experimental research, and it is safe to say that had it not been for this

fund English science in general would have been the poorer, and the Royal Institution in particular would not possess the international reputation it bears to-day—a reputation won, be it remembered, in the good old English way, without state subvention or government aid. Modern scientific research daily becomes more costly, because apparatus grows in delicacy and complication, on the one hand, and in size and weight, on the other, and thus there arises a proportionate increase in the need for individual generosity. The fact that such pecuniary aid has been forthcoming in the last century warrants the expectation that the stream of benefactors to the Royal Institution will not fail in the next, and that they will enable it to point to as proud a record on its second centenary as it now does on its first.

SCIENTIFIC BOOKS.

The Elements of Practical Astronomy. By W. W. CAMPBELL. New York, The Macmillan Company. 1899. Second Edition, Revised and Enlarged. Pp. xii + 264. Price, \$2.

This second edition of a work favorably known to American astronomers who are charged with the duty of instruction appears in bulkier form and better mechanical execution than its predecessor, but with its general character not very greatly altered. Its merits and defects are to be estimated from the standpoint assumed by the author, who assures us that "My experience in presenting the elements of practical astronomy to rather large classes of students in the University of Michigan led me to the conclusion that the extensive treatises on the subject could not be used satisfactorily, except in special cases." In this opinion we heartily concur and, absolving the author from obligation to deal with the more specialized and recondite parts of his subject, we find his self-imposed task properly expressed in the words "It is intended that this book shall contain the elements of practical astronomy with numerous applications to the problems first requiring solution." For this

purpose one may properly enough select the conventional material and methods found in such authoritative treatises as those of Chauvenet and Bruennow, and for the most part this has been done in the present work with great fidelity, although the author has found room for some few ameliorations of astronomical practice. The material selected for presentation is that leading up to the determination of time, latitude and azimuth with portable instruments, together with a brief treatment of the meridian circle and equatorial telescope and a welcome chapter, not usually found in such works, upon the surveyor's transit. This really efficient instrument has been strangely neglected by astronomers, and its astronomical capabilities find scant appreciation even in the present work, whose author, doubtless through a slip of the pen, appears to consider the accuracy attainable with it to depend upon the least count of the verniers. A further most welcome innovation, which the author has not seen fit to make here, but which we bespeak for a future edition, would have been the introduction of an elementary treatment of the spectroscope considered as an adjunct to the equatorial telescope.

As a whole the work may be cordially commended, but its general excellence is marred here and there by sins both of omission and commission. Opinions may differ as to the author's wisdom in appending to the text a bald exhibit of the principal formulæ of the method of least squares, with no pretense at their derivation and with but little explanation of their use, but surely 'the best modern practice of observing' does not justify the giving up of four per cent. of the entire treatise to such antiquated matter as lunar distances and the ring micrometer, nor does the scope of a beginner's book seem to call for giving up another four per cent. to diurnal parallax as affected by the earth's compression, although precedent for such treatment may be found in the standard works.

The author's methods of observation and computation are for the most part those of Chauvenet, an excellent model for half a century ago, but one which now admits of improvement in respect of formulæ to be employed for the reduction of observations. The general in-

troduction of addition and subtraction logarithms into all the better logarithmic tables in common use has removed that supposed necessity for 'adapting formulæ to logarithmic computation' under which the older writers labored, and in many cases permits their formulæ, and those of Professor Campbell, to be considerably simplified. An instance in point may be found at p. 107, where the author derives the hour angle of a star from its measured altitude through the formula for $\tan \frac{1}{2} t$ and is obliged to write down seventeen numbers for this purpose. The same result may be derived through $\cos t$ and the addition and subtraction logarithms with thirteen numbers, and the latter result is in no wise inferior to the former in respect of the unavoidable errors in logarithmic computation. In this particular case the two methods, when applied with five-figure logarithms, give results which differ by only one second of arc, after correction of two errors in the the author's computation which make his printed hour angle 74'' wrong.

A similar case occurs at page 199, where the author introduces the parallactic angle into the formulæ for determining the azimuth of a circumpolar star when its declination, hour angle and the latitude are given. In the example given to illustrate these formulæ and solved at p. 201 with six-figure logarithms the author writes down nineteen numbers in order to pass from t to A , where the ordinary formula which furnishes $\tan A$ directly in terms of the data permits the transformation to be made with eleven numbers. In respect of precision the short method has an even greater advantage, and when applied with five place tables will in general give results as precise as can be obtained with six place tables by the method of the text.

Throughout his entire work the author appears to have ignored the advantage offered by addition and subtraction logarithms, with results distinctly unfavorable to his formulæ. Another example of correct and conventional but cumbrous methods of reduction may be found in connection with the readings of a spirit level, p. 80. By the use of diagonal differences the result may here be found and checked without writing down a single figure.

The rather tedious treatment of the transit instrument in 45 pages contains no reference to two innovations, the most important since the invention of the chronograph, which have been successfully introduced into modern European practice with this instrument. The invention of the transit micrometer has furnished a simple and effective means of almost perfectly eliminating the influence of personal equation in transit observations, and the practice which has come into vogue in connection with this micrometer, of reversing the instrument upon every star observed, equatorial as well as polar, is revolutionary in its effect upon work with a portable transit. This reversal may be employed equally well with any good form of transit, and furnishes the very great advantage of automatically eliminating from the observation of each star a host of errors, such as the effects of collimation, flexure, inequality of pivots, etc., and the further signal advantage that the number of unknown quantities in the observation equation furnished by the star is reduced from the three or four recommended by the author to two. A work in which these advances are ignored is of doubtful service in 'illustration of the best modern practice' with the transit instrument.

The most serious general criticism to be brought against Professor Campbell's treatment of his subject is illustrated above; that he has not chosen methods and formulæ with sufficient reference to economizing the time and labor of the computer, although for the guidance of the latter, in matters left to his own judgment, there is furnished in Appendix A an excellent series of hints on computing.

Other points at which the author nods in varying degree from obscurity of statement to absolute error are the foot-note to p. 207 relative to projecting the sun's image upon a screen by 'focusing the eye-piece so that the images of the sun and wire are seen on the paper' and the statement, p. 75, that in the determination of the value of a revolution of a micrometer screw from transits of a star 'the effect of refraction is inappreciable if the observations are made near the meridian.' The first quotation is technically correct, but few students would infer from it that two distinct operations are to be

performed, one of which in the ordinary type of instrument consists in moving the objective. The second quotation is quite wrong if more than three significant figures are required in the result and in the illustrative example given by the author, by neglecting the refraction he has vitiated the final result to an amount twice as great as the probable error which he assigns to it.

An error made with all the emphasis of italics requires that an altitude measured from the sea horizon shall be corrected for refraction before the dip of the horizon is taken into account, and another error occurs at p. 160 (and also in the first edition of the work) where the rate of a chronometer is represented as a linear function of the temperature, although experience and theory alike indicate that the relation between these quantities must be expressed by an equation of at least the second degree.

It is very doubtful if a consensus of astronomical opinion could be brought to sanction the method of reduction of zenith telescope latitudes recommended by the author, viz: a least-square solution in which the value of a level division is introduced as an unknown quantity. Under all ordinary conditions the observations should be so conducted that the direct determination of this quantity shall far outweigh any value which can be derived from the latitude observations.

The mechanical execution of the work is excellent; it is provided with an adequate index and illustrated by cuts which are in the main well chosen, although here we regret that the author has selected as 'an excellent form of the prismatic (broken) transit' an instrument which is a complete failure and has been consigned to oblivion by the government bureau for which it was constructed.

G. C. C.

Infinitesimal Analysis. Vol. I., Elementary: Real Variables. By WILLIAM BENJAMIN SMITH, Professor of Mathematics in Tulane University. New York, The Macmillan Company. 1898. 8vo. Pp. xvi + 352. Price, \$3.25.

The book in hand is the initial volume of a treatise in course of composition which is to

consist of three volumes. Concerning the merits of this first part in so far as these may ultimately depend on its relations to the rest of the work, it would be premature to form an opinion. Apart, however, from this contingent and inchoate character of the volume, it has a unity and maturity of its own, being avowedly written as an introduction to the calculus, and as such is properly before the public for review.

The author's aim has been "to penetrate as far as possible, and in as many directions, into the subject—that the student should attain as wide knowledge of the matter, as full comprehension of the methods, and as clear consciousness of the spirit and power of this analysis as the nature of the case would admit." It is not easy to realize so high and composite an ideal. The nature of the case, it is well known, presents some grave difficulties. Of these the most obstinate inheres in the combination of doctrine and applications, of the general and abstract with the particular and concrete, in securing, despite the fragmentariness incident to illustration and example, the effect of unity and wholeness in the development of theory. French and German writers, such as Jordan, Harnack, Stolz, escape the difficulty of combining theory and practice by simply ignoring the latter. By this easy disregard of the needs of all students except specialists in graduate years, these authors are enabled to attain a coherency and symmetry of development which lend to their work, besides the scientific, something of an artistic character. The Englishman, on the other hand, is prone to lose both of these advantages by sinning in the opposite direction, by a distinct subordination of theory to practice, a collocation, however interesting and useful, of exercises for the ingenuity of students, being neither an æsthetic nor, in strictness, a scientific production.

The problem of overcoming instead of dodging the difficulty in question, of escaping the mentioned vices without losing their peculiar virtues, admits of only approximate solution. The necessary compromise has, as is well known, been skilfully effected in German in the deservedly much-praised treatise by Kiepert. In the book under review a notably similar success has been achieved in English. In fact,

these two works, though differing widely in method and detail, are closely allied in spirit and aim. The motive in both is to guide and inspire; both are honest, anxious not to deceive, faithful in indicating assumptions and limitations, and, while seeking first to be intelligible, are in general as rigorous as circumstances will allow. Neither author forgets that in last analysis his science resides in theory, which, therefore, properly receives the greater emphasis. Nevertheless, both works abound in concrete examples. These, curiously enough, are nearly all worked out in the German text, while in the English most of them are, as usual, left as exercises for the student.

In point of matter these works are not coincident nor coextensive either with one another or with their rivals, such as the treatises by Edwards, Williamson and Greenhill. For example, Kiepert gives a concise preliminary treatment of certain algebraic themes, as the binomial theorem, the potential and logarithmic series, convergency and divergency, determinants and others, while Smith has, for the sake of brevity, presumed knowledge of some of these, treatment of others being reserved for Vol. II. A like reservation is made in case of the complex variable, and, save for an elegant though very brief account, in case also of differential equations, to each of which topics Kiepert gives an introduction. On the other hand, Smith, like Williamson, deals with the gamma functions and inserts a helpful chapter on curve tracing, while Kiepert excludes the former subject and considers the latter but incidentally. The omission by the American, as by the German, of the theory of probability and the calculus of variations is a noticeable departure from British precedent.

The opening chapter of the volume before us is, in many respects, an admirable presentation of fundamental concepts and operations. The path pursued leads quickly into the heart of the subject. The student meets first things of first importance. The notion of limit is at once lifted into prominence, being carefully unfolded at the very outset, and employed without delay in definition and proof. The infinitesimal is correctly defined, and its *subjective* character is pointed out, the fact, namely, that

its essence consists not in any value it may assume, but in our power over it to make it small at will. The advantage of introducing the infinite in connection with the infinitesimal is not availed of; the former notion is, in fact, not defined at all. Similarly, the discussion of infinitesimals of higher order would have been enhanced by mention at least of the complementary topic. The author retains the entire respectable but obsolescent definition of algebraic function, the modern definition of such function as the root of an equation having coefficients rational in the independent variable, being apparently nowhere employed. Continuity is not adequately treated, and this preëminently important subject will doubtless be accorded suitable recognition in the next volume. Numerous examples of discontinuity, such as are given by Kiepert, are well-nigh indispensable aids to the student, whose attention, moreover, might with profit have been *explicitly* directed to the fact that the derivability of a function always implies, though is not implicit in, its continuity. The idea of uniform continuity is introduced, but only on occasion, as in the deduction of the theorem of total differential. On p. 11 the reader is warned against regarding $\frac{dy}{dx}$ as a fraction, and on p. 79, where the differential notation is explained, he is cautioned against 'attempting a magnitudinal interpretation' of du and dx in the 'symbolic equation $du = u_x dx$,' which 'means that the derivative of u as to x is u_x .' The author's view of this critical matter, while not in full accord with that, for example, of Jordan's *Cours*, p. 61, is nevertheless intelligible, consistent and adequate.

The early introduction (Chapter II.) of the notions of integral and integration is attended with obvious advantages. The treatment is good scientifically and pedagogically. A specially commendable didactic feature is the calculation of several integrals by actually making the required subdivisions, forming the corresponding products, generalizing, and throwing the summation into a form suitable for perceiving its limit.

Space is wanting for briefest comment on many interesting sections as those dealing with illusory forms, maxima and minima, geomet-

ric interpretation of higher derivatives, change of variable, partial integration, Jacobians, multiple integrals, parametric derivation, and so on.

It remains to say that not the least praiseworthy quality of the book is found in its style. To be scientific it is not necessary to be vulgar. The volume affords another illustration of the compatibility of rigor and austerity of thought with a generous regard for the amenities of expression. To many the book will be distinctly the more attractive because of its human flavor, its dialectic color, its life, an occasional glance at the philosophic phases of the subject. A rare union of conciseness with precision and clearness is characteristic. For judicious accentuation little more could be desired. The reader is taken into confidence, invited to accompany rather than to follow. The work is not a compilation and not a mechanical structure; it is rather an organism, a growth, notable for its merits, though, of course, sharing in a measure the imperfections of its kind.

C. J. KEYSER.

COLUMBIA UNIVERSITY.

Defective Eyesight; The Principles of its Relief by Glasses. By D. B. ST. JOHN ROOSA, M.D., LL.D., Professor Emeritus of Diseases of the Eye, New York Post-Graduate Medical School and Hospital; Surgeon to the Manhattan Eye and Ear Hospital; Consulting Surgeon to the Brooklyn Eye and Ear Hospital, etc. New York, The Macmillan Company. 1899. 8vo. Pp. 193.

This work is practically a revised edition of the author's little book 'On the Determination of the Necessity for Wearing Glasses,' published as one of the 'Physician's Leisure Library Series' in 1887, by George S. Davis, of Detroit, Michigan.

The volume has gained much by its revision, has had some excellent illustrated matter introduced and has been considerably enlarged.

The subject is divided into seven parts, all of which are written in the author's well-known easy style, making those who have had the pleasure of personally reading his writings more firmly convinced of his earnestness and erudition.

Considering the subject-matter in its given

order, a most interesting historical notice of the first attempts to accurately estimate the visual power, the invention of the ophthalmoscope and the apparatus required for testing vision opens the volume. This is followed by a comprehensive description of presbyopia, myopia and hypermetropia.

Astigmatism in its various forms is taken up next, under which heading an extended account of ophthalmometry to its minutest detail is given. Asthenopia, particularly that which is found in association with binocular vision, is described in a graphic manner, while a number of useful general remarks as to lenses, spectacles and eye-glasses finish the volume.

A careful perusal of the contents of the work is recommended to any one who may be interested in the subject.

C. A. O.

BOOKS RECEIVED.

German Higher Schools; The History, Organization and Methods of Secondary Education in Germany. JAMES E. RUSSELL. New York, London and Bombay, Longmans, Green & Co. 1899. Pp. xii + 455.

Year-book of the United States Department of Agriculture, 1899. Washington, Government Printing Office. 1899. Pp. 768.

Imperial Democracy. DAVID STARR JORDAN. New York, D. Appleton & Co. 1899. Pp. viii + 293. \$1.50.

Eighteenth Annual Report of the United States Geological Survey, 1896-97. CHARLES D. WALCOTT, Director. Part II., Papers Chiefly of a Theoretical Nature. Part IV., Hydrography. Washington, Government Printing Office. 1899.

SOCIETIES AND ACADEMIES.

THE BIOLOGICAL SOCIETY OF WASHINGTON.

THE 306th regular meeting was held April 8th. The first paper entitled 'The Ferns of Hemlock Bluff' by Mr. Wm. Palmer included a preliminary sketch of the geology of Hemlock Bluff, a point on the Virginia shore of the Potomac between Georgetown and Great Falls. The locality is particularly rich in cryptogamic plants, over twenty species of ferns being enumerated.

A recent noteworthy addition to this list is that of *Asplenium pinnatifidum* hitherto unknown from the District of Columbia or the

adjacent parts, and supposed to be confined to limestone rocks in mountain regions. The rocks at Hemlock Bluff are, however, gneissic. Mr. Palmer stated that this interesting and beautiful station is threatened with destruction, and expressed the hope that Congressional action would be taken in time to protect the banks of the Potomac from further devastation.

'Notes on the Habits of African Termites' was the subject of the second paper, read by O. F. Cook. On the basis of observations made in Liberia several points in the domestic economy of termites have been established. Among these may be mentioned the fact that some termites regularly collect rotting wood, which they put through a process of curing and then comminute into the pulp used in building the irregularly honeycombed fungus gardens which produce the food of at least the young animals of the colony. The soldiers of these species (*Termes bellicosus* and allies), which sally out from the nest in response to attacks by men or animals, do not return to the nest, but wander about and soon perish from exposure to the outside air. Other soldiers, the so-called *nasuti*, of which the head is produced above into a long beak, eject from this process, which is hollow, a transparent, acrid, malodorous and corrosive fluid, which forms a most effective means of defence against ants and other insect enemies, and renders them distasteful to birds. A third type of soldier can neither shoot nor bite, but the large, unequal mandibles are especially adapted to produce a loud clicking sound which furnishes protection at least against other species of termites. It was also found that the perfect insects associate in pairs when flying over water and that, after dropping their wings, such pairs are able to burrow into the ground, thus suggesting the possible origin of termite communities.

Under the head of 'Biological Characteristics as a means of Species Differentiation' Dr. Erwin F. Smith described in detail the very numerous culture-methods, reactions and other tests now in use in bacteriology. To accomplish all these investigations a species is sometimes carried in the laboratory for two years or longer. The insufficiency of the older and, indeed, of many of the more recent descriptions

was noted. The descriptive methods applicable to larger organisms here fail almost completely, necessitating that diagnoses depend upon physiological facts which receive little attention in the descriptions of species belonging to groups of greater structural complexity.

At the 307th meeting, April 22d, Dr. S. D. Judd gave an account of a recent observation on chimney-swifts. A large flock was seen flying in a circle at great height and then gradually descending over a chimney of Georgetown College, which they finally entered. Discussion followed by Dr. L. O. Howard and Professor E. L. Morris. The latter had noticed that individual swifts leave the flock in small parties of equal size until near the end of the flight, when the remaining birds hurry into the chimney without any regularity of procedure.

Professor T. D. A. Cockerell then opened the regular program with a paper on the 'Fauna and Faunulae of New Mexico,' in which he described the various life-zones of New Mexico, beginning with summits of the mountains. The different belts are usually well marked and are best designated by the names of abundant and characteristic plants, such as the spruce, piñon, scrub-oak, *Dasyllirion*, *Yucca*, *Larrea* and *Atriplex canescens*. One of the most notable peculiarities of New Mexican conditions is that the *Larrea* belt, supposed to represent the Lower Sonoran zone, occurs on the bases of the mountains above *Atriplex canescens*, which is considered a more northern type. This apparent anomaly is explained by the fact that the bottoms of the valleys are visited by currents of cold air which render the changes of temperature more rigorous than at somewhat greater elevations. In all groups the species of the New Mexican region are largely peculiar, doubtless to a considerable extent the result of the fact that the naturalization of introduced species is rendered extremely difficult by the severe late frosts which native forms avoid by remaining dormant through the generally very warm weather of early spring.

In the course of the ensuing discussion Dr. Merriam explained that the conditions described by Professor Cockerell were considerably different from those studied by himself in

Arizona, while Mr. Osgood noticed a close parallel in some of the valleys of California. Mr. Coville suggested that Professor Cockerell's *Atriplex* might prove to be *A. tetraptera*, *A. canescens* being a plant of more northern distribution. Dr. Loew related experience gained while a member of the Wheeler Expedition (1872-1875), which led him to the view that the cold air which collects in the bottoms of valleys sinks on account of its greater weight, causing the warm air to rise along the slopes of the mountains, which are thus maintained at a higher temperature. Dr. Merriam resumed the discussion and explained how in a similar way upward currents of warm air are formed in valleys of more heated southwestern slopes of mountains, frequently permitting the extension of the flora and fauna of the valley to an altitude sometimes 2,000 or 3,000 feet above the normal.

The next paper, 'Some Microchemical Reactions resembling Fungi,' by Dr. A. F. Woods, explained that living protoplasm of plant cells, when treated with certain reagents in common use in histological investigations, will form precipitates which closely resemble and have been mistaken for fungi supposed to be living as parasites inside the cell. Dr. Woods had been able, by adding very gradually such a reagent (*eau de Javelle*), to observe the progress, in living cells of the Bermuda lily, of a reaction closely similar to the appearances which have been described by Viala and others as a species of *Plasmodiophora* and which they believed to be the cause of a disease of the grape. The paper was illustrated by specimens and photographs.

The program was concluded by Dr. Oscar Loew with a paper on 'The Fermentation of Tobacco.' The processes of tobacco curing and fermentation were described. The rise in temperature and improvement in flavor during the latter process have been in recent years uniformly ascribed to the presence of bacteria, and many attempts to isolate the specific germ have been made, several of which have been reported as successful. Dr. Loew finds, however, that bacteria have no part in these changes, that the conditions are unfavorable for the growth of bacteria, there being too little moisture, and

finally, that even such bacteria as may have been accidentally present on the leaves are killed in the curing process. He has discovered two oxydizing enzymes the proportions of which are determining factors in the production of the color and aroma of tobacco. Faulty methods of curing may destroy these enzymes and prevent the changes which bring about improved flavor. The nicotine, which does not exist in the fresh leaf, is one of the products formed during the action of the enzymes.

Professor Whitney offered the opinion that Dr. Loew's discoveries were to be looked upon as the beginning of a scientific understanding of the processes of acquiring color and aroma, and that they marked a new departure of great scientific and practical importance. Dr. Loew then replied to various questions by Dr. de Schweinitz and others.

O. F. COOK,
Secretary.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 503d meeting of the Society was held in the assembly room of the Cosmos Club at 8 p. m., May 27th. The first paper was by Mr. Frank Radelfinger on 'Some Recent Researches on Linear Differential Equations.'

After a brief introduction reviewing and summarizing the methods used in the solution of differential equations before the introduction of the complex variable into analysis the work of Fuchs on the theory of linear differential equations was considered and its salient points denoted. The researches of Thomé and Poincaré on equations with irregular integrals were very briefly treated, and then came the principal part of the paper, giving an account of the recent introduction of the ideas of the Galois-group theory into the theory of the linear differential equation. The work of Picard and Vesiot was discussed. A statement of the principal theorems of the linear group was given and their analogy to those relating to the symmetrical group of algebra mentioned. A concise statement of the theory of irreducibility and its application to the theory of linear differential equations was made, and it was shown that the results obtained by the group theory when combined with this idea furnished us with a

rational basis for their classification. This was illustrated by making an application to the case of an equation of the second order. The conditions that must be satisfied by a linear equation in order that it may be integrated by quadratures was next discussed. In conclusion, some points to be perfected in the theory of equations with irregular integrals were indicated and mention made of recent researches in the theory of divergent series that may throw some light on these points; the importance of the group theory was mildly emphasized and a statement made of the results to be expected from its further application to the theory of linear differential equations, especially in regard to arithmetization of this theory.

The second paper was by Mr. Louis D. Bliss on 'Hertzian Waves as applied to Wireless Telegraphy and Firing of Guns from a Distance.' The substance of Mr. Bliss's remarks was as follows: Upon the electro-magnetic theory of light proposed by Maxwell in 1867 Hertz in 1888 succeeded in producing signals through space, without the aid of any material medium, by the propagation of electro-magnetic waves. For a transmitter he employed an 'Oscillator' and for a receiver a 'Resonator' of special design.

Marconi, in 1895, reduced to practical form what was thus far experimental, by the construction of a 'Coherer' or 'Electric Eye,' consisting of a glass tube filled with metal powder on which the waves could strike. The resistance of the powder was thereby greatly diminished on account of the cohesion of the particles under the influence of the waves. This permitted a battery (which was constantly in circuit) to force a powerful current through the device, and thus operate a telegraph relay or sounder, or operate a fuse to fire a cannon, mine or other device at will. These signals may now be transmitted through space between stations 30 miles apart, the height of the vertical wire which must be connected to the apparatus at each station varying as the square root of the distance. (Demonstrations of firing a cannon without wires and telegraphy through space were made.)

E. D. PRESTON,
Secretary.

SECTION OF ASTRONOMY AND PHYSICS, OF THE
NEW YORK ACADEMY OF SCIENCES,
MAY 1, 1899.

THE regular meeting of the Astronomy and Physics Section was held at 12 West 81st Street, New York, on May 1, 1899, Professor Pupin, the Chairman of the Section, presiding.

The first paper, describing experiments by Professor Pupin and Mr. F. Townsend, on the magnetization of iron with alternating currents, was read by Mr. Townsend. The paper was only a preliminary account, as the experiments are still in progress. The current wave in a transformer with open secondary circuit is a complex harmonic vibration, and the particular object of this research is to determine the amplitudes and phase relations of the components of the fundamental vibration.

The component due to eddy currents is determined from the curves of electromotive force and current, together with the static hysteresis loop for the given magnetization, by a graphical method. The eddy current component is found to lag behind the electromotive force. Also, the dynamic hysteresis loop is found to have a rounded point, as distinguished from the sharp point characteristic of the static loop.

The phase of the fundamental of the total current wave is found by means of a specially constructed phase meter. Its amplitude is determined from the electromotive force and total watts.

The remaining component to be determined is that due to hysteresis and induction reaction. This and the eddy current component form two sides of a parallelogram of which the fundamental of the total current wave is the diagonal. If the last two are determined in amplitude and phase the fundamental of the distorted wave of magnetizing current can readily be found.

The ultimate object of the investigation is to formulate the laws which govern the reactions accompanying the magnetization of iron by alternating currents.

The second paper was by Mr. C. C. Trowbridge on phosphorescent substances at liquid-air temperatures. Calcium sulphide, made phosphorescent by exposure to sunlight at ordinary temperatures, was made non-luminous by

immersion in liquid air. Then, when allowed to heat up gradually to normal temperature, the phosphorescence again became visible at about -100° to -75° C. The same material, if exposed to sunlight while immersed in liquid air, phosphoresced faintly while still immersed. When exposed to the electric arc it phosphoresced strongly. In both of these cases the phosphorescence became brighter when the temperature was raised. From these results, and what was previously known, it was concluded that when a phosphorescent substance like calcium sulphide is excited by light the phosphorescent energy will be given up at the temperature of excitation even when as low as -190° C. But if it is cooled below the temperature of excitation the phosphorescent discharge is arrested, and remains so until the temperature is raised again until it is within at least 100° of the temperature of excitation.

It was found that calcium tungstate, which gives a whitish fluorescence when exposed to Röntgen rays, gave a green phosphorescence when exposed to light while immersed in liquid air.

WM. S. DAY,
Secretary.

DISCUSSION AND CORRESPONDENCE.

CEREBRAL LIGHT: FURTHER OBSERVATIONS.

IN SCIENCE, 1897 N. S. VI. 138, I published a set of observations to prove that what is at present considered to be retinal light arising from chemical changes in the retina is really not derived from the retina but from the brain. The observations were essentially: 1. That there was only one field of light instead of two, and that this field showed no signs of binocular union, binocular strife or stereoscopic union. 2. That the figures in the light do not change as the eye moves, but follow the movement later. 3. That the figures do not show movement when the eye is displaced by pressure with the fingers. A recent German reviewer, while admitting the possibility that the light is cerebral and not retinal, refuses to accept my observations as sufficient proof.

Last night I was able to perform what seems to be a crucial experiment; I record its results

while they are fresh in mind. I observed the cerebral figures for some hours, repeating the observations previously reported. When the dawn faintly illuminated the window frame I was able at one stage of brightness to see both the frame and the figures. Placing the fingers of the two hands against the outer ends of the eyeballs, I displaced them simultaneously in opposite directions; this was repeated a number of times in rapid succession. As a result there appeared two images of the frame moving in opposite directions. The retinal figures seen in front of the frame still remained single and did not move. Granting that there was no error in my observation, I cannot imagine a more conclusive proof as to the cerebral nature of the light.

The problem is really one of importance. If this light is cerebral we have a means of distinctly observing some of the phenomena in the brain. The cerebral figures are intimately associated with the contents of dreams. I believe also that the forms of the figures of cerebral light are intimately connected with the phenomena of nutrition in the brain. I find at the present time that my figures are quite different from those which I have been accustomed to observing in past years; this may correspond to a radical change in the condition of the nervous system which I have observed to have taken place during the past six months. I find also that the figures on first awakening from sleep are very different from those that are seen when the mind becomes fully awake. Systematic observations by medical men may show that diagnostic conclusions can be obtained by asking patients to describe their cerebral figures.

The question at the present time concerns the sufficiency of the observations. If they are correct and reliable there is, I believe, no escape from the conclusion that the figures are cerebral. I can see no reason to believe that my carefully and repeatedly made observations are erroneous, but it is highly desirable to have them confirmed by other observers.

E. W. SCRIPTURE.

PSYCHOLOGICAL LABORATORY,
YALE UNIVERSITY, NEW HAVEN, CONN.,
May 29, 1899.

PROFESSOR SIMON NEWCOMB.

THE issue of *Nature* for May 4th contains an admirable portrait in photogravure of Professor Simon Newcomb, together with an article describing his scientific work by M. Loewy, Director of the Paris Observatory. M. Loewy says:

Newcomb must be considered, without contradiction, as one of the most celebrated astronomers of our time, both on account of the immensity of his work and the unity of view which marks the choice of the subjects treated by him.

All is linked together in our solar system; the study of the motion of each one of the celestial bodies forming part of it is based upon the knowledge of a great number of numerical data, and there exists no fundamental element whose influence is not reperused on the entire theory of these bodies. To endeavor to build up the theory of our whole planetary world on an absolutely homogeneous basis of constants was an almost superhuman task.

After giving an extended account of some of Professor Newcomb's more important contributions M. Loewy concludes:

We have only been able to give a short sketch of Newcomb's achievements; he is gifted with a prodigious power of work, which is testified by the extraordinarily long list of his researches.

The reception which has been accorded to them by all competent men points to their author as one of the most illustrious representatives of celestial mechanics.

This activity has embraced the most diverse branches of astronomy. Not only has he given a great scope to the intellectual movement of his country, but he has also contributed, in a very successful manner, to elevate the level of the civilization of our age, enriching the domain of science with beautiful and durable conquests.

SCIENTIFIC NOTES AND NEWS.

OXFORD University conferred, on June 8th, the degree of D.C.L. on Professor Simon Newcomb.

THE new biological laboratory of Adelbert College, Western Reserve University, was dedicated on June 13th. An address was delivered by Professor W. K. Brooks.

PROFESSOR W. C. BRÖGGER, of the University of Christiania, the distinguished Norwegian geologist, has accepted an invitation to deliver the second course of the George Huntington Williams memorial lectures at the Johns Hopkins

University, in April, 1900. Professor Brögger has published a series of memoirs upon the geology of southern Norway that have given him rank among the leading investigators of his time. Professor Brögger comes as the successor in the Williams course to Sir Archibald Geikie, the Director-General of the Geological Surveys of Great Britain and Ireland, who opened the lectureship two years ago with a course upon 'The Founders of Geology.' Professor Brögger will lecture upon 'Modern Deductions regarding the Origin of Igneous Rocks.'

PRESIDENT MCKINLEY has appointed a commission to determine the best route for a canal across the Isthmus of Panama or Nicaragua as follows: Rear-Admiral John G. Walker, retired; Samuel Pasco, of Florida; Alfred Noble, C. E., of Illinois; George S. Morrison, C. E., of New York; Colonel Peter C. Hains, U. S. A.; Professor William H. Burr, of Columbia University; Lieutenant-Colonel Oswald H. Ernst, U. S. A.; Lewis M. Haupt, C. E., of the University of Pennsylvania, and Professor Emory R. Johnson, of Pennsylvania. The sum of \$1,000,000 has been appropriated for the expenses of the Commission and a number of surveyors will accompany the party which will shortly leave for Colon.

THE Editorial Board of the *National Geographic Magazine* has been enlarged, and, as appears from an announcement in the June number, an effort is being made to extend the field of usefulness of the journal. The new Board is as follows: Editor, John Hyde, Statistician of the U. S. Department of Agriculture; Associate Editors, A. W. Greely, Chief Signal Officer, U. S. Army; W. J. McGee, Ethnologist in Charge, Bureau of American Ethnology; Henry Gannett, Chief Geographer, U. S. Geological Survey; C. Hart Merriam, Biologist of the U. S. Department of Agriculture; David J. Hill, Assistant Secretary of State; Charles H. Allen, Assistant Secretary of the Navy; Willis L. Moore, Chief of the U. S. Weather Bureau; H. S. Pritchett, Superintendent of the U. S. Coast and Geodetic Survey; O. P. Austin, Chief of the Bureau of Statistics, U. S.; Eliza Ruhamah Scidmore, author of 'Java, the Garden of

the East,' etc.; Carl Louise Garrison, Principal of Phelps School, Washington, D. C.; Assistant Editor, Gilbert H. Grosvenor, Washington, D. C.

THE Cape of Good Hope University has conferred the degree of D.Sc., on Mr. A. W. Roberts, of Lonsdale, for his astronomical discoveries and the degree D.Litt. on the Rev. Dr. Brincker for researches on the native language.

PROFESSOR KOCH and his assistants have been pursuing their investigations on malaria at Grosseto, a town between Rome and Genoa, where much land has been reclaimed from the marshes, thus greatly reducing the prevalent malaria.

PROFESSOR LAES FREDRIK NILSON, Director of the Agricultural Chemical Experiment Station at Stockholm, died on May 14th, aged 59 years.

M. ADOLPHE LEGAL, a French geologist, has been killed by the natives while making explorations in the French Soudan.

A CABLEGRAM to the daily papers from Japan states that a party of scientific men, eleven Japanese and one German, the names not being given, while making explorations near Tosang, on the Liao Tung Peninsula, were made prisoners by Russian cavalry and shot as spies, without a trial.

WE are requested to announce that the Royal Academy of Sciences of Turin will award in 1908 the first Vallauri prize for the most important work on physical science (the term being used in its widest sense) published during the four preceding years. The value of the prize is about \$6,000, and it is open to Italians and foreigners on equal terms. Professor Tommaso Vallauri, Senator of the Kingdom of Italy, who died in 1897, left his whole estate to the Turin Academy for the establishment of two prizes, one for scientific research and the other for the study of Latin literature.

WE have now received a proof of the announcement of the approaching Dover meeting of the British Association, which, however, does not contain much information beyond what has already been published. The President, Professor Foster, will deliver his address on Thursday evening, September 14th. Professor Charles Richet will lecture on Friday evening on 'La vi-

bration nerveuse,' and on Monday evening Professor Fleming will lecture on the 'Centenary of the Electric Current.' Members of the Association Française pour l'Avancement des Sciences will visit Dover on Saturday, September 16th. Members of the British Association are invited to visit Boulogne on Thursday, September 21st. The Vice-Presidents for the meeting are the Lord Archbishop of Canterbury, the Marquis of Salisbury, the Mayor of Dover, the Major-General Commanding the Southeastern District, the Right Hon. A. Akers-Douglas, M.P., the Rev. F. W. Farrar, Dean of Canterbury, Sir J. Norman Lockyer and Professor G. H. Darwin.

THE Swiss Society of Natural Sciences will hold its 82d annual meeting at Neuchâtel from the 31st of July to the 2d of August. In addition to a number of special lectures the Society meets in seven sections as follows: (1) Physics, Mathematics and Astronomy; (2) Chemistry, Pharmacology and Hygiene; (3) Zoology and Anthropology; (4) Botany; (5) Geology, Paleontology and Mineralogy; (6) Medicine, and (7) Agriculture. At the same time the Swiss Societies of Geology, Botany and Zoology hold their annual sessions. A number of interesting excursions have been arranged and foreign men of science are assured of a cordial welcome.

THE position of superintendent of tree planting in the Division of Forestry, Department of Agriculture, salary \$1,800 per annum, will be filled by Civil Service examination on July 11th. The subjects and weights are as follows:

- | | |
|--------------------------------------|----|
| 1. Forestry and Tree-planting, | 60 |
| 2. Botany, | 10 |
| 3. English, | 10 |
| 4. Training and Experience, | 20 |

THE position of instrument maker at the Naval Observatory, Washington (salary, \$1,500 per annum), will be filled by an examination on the same day. The examination will be almost exclusively confined to practical questions relating to the construction and mechanical operation of telescopes of large size.

THE recent action of President McKinley providing for the exemption of the higher scientific positions in the Smithsonian Institu-

tion from Civil Service examinations was taken at the recommendation of the Board of Regents, who find that leading men of science will not take these examinations.

THE annual convention of the Association of Agricultural Colleges and Experiment Stations will be held in the hall of the California Academy of Sciences, from the 5th to the 7th of July. In addition to the ordinary meetings, which are always of much interest, arrangements have been made for an excursion of the delegates on a special train for a study of the agricultural industries of California. It will be possible for delegates to make the trip to California by paying about a single fare. Further information may be obtained from the Secretary, Professor Edward B. Vorhees, New Brunswick, New Jersey.

THE Association of Official Agricultural Chemists will hold its sixteenth annual meeting at the same time and place as the Association of American Agricultural Colleges and Experiment Stations. Information concerning this meeting can be secured by addressing the Secretary, Dr. H. W. Wiley, Department of Agriculture, Washington, D. C.

THE American Medical Association held its fiftieth annual meeting at Columbus, Ohio, last week. The President, Dr. Joseph M. Matthews, in his address, recommended that the society be permanently located in Washington, and that its journal be published in that city. Professor W. W. Keen, of Philadelphia, was elected President of the Association, and it was decided that the next meeting should be at Atlantic City, New Jersey.

THE Congress of the Royal Institute of Public Health of Great Britain will be held in Blackpool from September 21st to September 26th, under the presidency of the Marquis of Lorne. There will be four Sections: (a) Preventive Medicine and Vital Statistics; (b) Chemistry and Meteorology; (c) Engineering and Building Construction; (d) Municipal and Parliamentary.

THE City of Bristol is now arranging for the establishment of a reference scientific library, made possible by a bequest of £50,000 from the late Mr. Stuckey Lean.

A TELEGRAM was received at the Harvard College Observatory on June 12th from Professor E. Keeler, at Lick Observatory, stating that comet Holmes was observed by Perrine June 10^h.9644 Greenwich Mean Time in R. A. 1^h 15^m 31^s.6 and December + 17° 29' 39'' Faint. This comet was originally discovered by Holmes in London, November 6, 1892, and has a period of about seven years. By January 12, 1893, it had become very faint, but on January 16th it was found to have undergone a remarkable change, an outburst of light having occurred. It resembled a bright planetary nebula of about the seventh magnitude, the nucleus being at first very hazy, but afterwards becoming sharper and about as bright as a star of the eighth magnitude. On January 1, 1894, it could not be found with the 26-inch refractor of the Washington Observatory, being then fainter than the magnitude 14.

Popular Astronomy gives an interesting statement of the progress which is being made in the new reduction of the Piazzi star observations. Dr. H. S. Davis, who recently resigned from the Columbia University staff, in order to devote himself more exclusively to this work, is to be congratulated upon the cooperation which his zeal has obtained. Professor Porro and Dr. Balbi, of Turin, will reduce the transit right-ascension observations, and Dr. Gill, of the Cape of Good Hope Observatory, will reobserve the southern Piazzi stars. All the Piazzi stars are being redetermined for 1900. Miss Flora Harpham is aiding most efficiently in the computation, while Miss Catharine W. Bruce places astronomy under still greater obligations of gratitude by generously contributing to remove the financial obstacles. In the twenty years about 1800 Piazzi made some 125,000 observations. When Dr. Davis has reduced these with modern accuracy they will afford a valuable catalogue of some 8,000 stars for the beginning of the century now closing.

At a meeting of the Royal Geographical Society, on May 29th, a paper was read by Dr. Francisco P. Moreno on 'Explorations in Patagonia.' According to the report in the *London Times* he pointed out that up to quite recent times the geography of the southern part of the

New World had been in a very backward state. Having recounted his own travels, he remarked that Patagonia did not merit the bad reputation given to it, but, on the contrary, a vast field for human initiative existed there, with a healthy soil capable of supporting a large population. It was evident to him that they had in Patagonia a portion of the Antarctic Continent, the permanency of which, in so far as its main characteristics were concerned, dated from very recent times. So, then, the history of the Patagonian plateau was connected with the problem of the southern continent, which to so great an extent had disappeared. He had handed to the staff of the British Museum duplicates of the extinct and present animal remains of Patagonia and of its flora, as well as of those obtained by the La Plata Museum, of which he was Director; and he trusted that, with such competent collaboration, it would soon be easy to give an exact idea of Patagonian biology.

At the annual meeting and conversazione of Selbourne Society, on May 31st, Sir John Lubbock, the President, spoke of the advantages of the Wild Birds' Protection Act and pointed out the importance of the enclosing of the unenclosed area of the New Forest.

At a meeting of the Accademia Medica di Roma, held on April 30th, Drs. G. Bastianelli and Bignami read a summary of the results of their investigations on the Cycle of Life of the Parasites of Tertian Fever in the *Anopheles Claviger*. They are, according to *The British Medical Journal*, as follows: The large pigmented forms of the Tertian parasites, incapable of multiplying in man, may be distinguished morphologically into two categories; some, with a large vesicular nucleus and little chromatin, represent the female (macrogamete); others, richer in chromatin, the male (microgametocyte of zoologists). In the middle intestine of the male *Anopheles Claviger* six microgamete (flagella) generally protrude, one of which fecundates a macrogamete after the chromatin of the latter has undergone a process of reduction. The fecundated macrogamete penetrates into the middle intestine of the *Anopheles*, where it develops,

passing through a cycle of life similar to that described by Ross for the proteosoma of birds in the gray mosquito, and by the anthus and grassi for the semilunæ in the *Anopheles Claviger*. In this cycle of life the Tertian sporozoon remains distinguishable by its morphological characters from that of semilunar origin; the young forms are distinguished principally by the form of the sporozoon and the characters of the pigment; the forms undergoing development by the size of the bodies produced successively by nuclear division; the mature forms are distinguished as a rule by the disposition of the residue of segmentation, perhaps also by the size. The distinction of the species of malarial parasites, therefore, remains unaltered. The same conclusion is also obtained from the third experiment, which demonstrates that the semilunæ which have given only Tertian at first, passing through the *Anopheles Claviger*, maintain unchanged their specific characters. The study of the life of the *Anopheles* in the Roman Campagna explains, in a satisfactory mode, the behavior of the Tertian at the change of the seasons. It has been demonstrated experimentally that very few punctures—indeed, even one only—by the infected *Anopheles* may produce the infection in man.

A CIRCULAR letter has been issued by the committee arranging for a University of Birmingham, asking for subscriptions to make the first endowment £300,000. A copy of Mr. Andrew Carnegie's letter giving £50,000 to the fund is enclosed. As this is of interest to American men of science we quote it in full:

Langham Hotel, London, May 9, 1899.

DEAR MR. CHAMBERLAIN.—You have interested me in your proposed University at Birmingham for the people of the Midlands. May I suggest that an opportunity exists for such an institution to perform a great service for the whole country? After the members of the Iron and Steel Institute had returned to New York from their tour of observation through the United States, the officials dined with me. Many pleasing short speeches were made; the close of one I have never forgotten. A partner in one of your foremost steel companies said: 'Mr. Carnegie, it is not your wonderful machinery, not even your unequalled

supplies of minerals, which we have most cause to envy. It is something worth both of these combined; the class of scientific young experts you have to manage every department of your works. We have no corresponding class in England.' Never were truer words spoken. Now this class you must sooner or later secure, if Britain is to remain one of the principal manufacturing nations, and it seems to me the Midlands is the very soil upon which it can most surely be produced. If I were in your place I should recognize the futility of trying to rival Oxford and Cambridge, which, even if possible, would be useless. These twin seats of learning have their mission and fulfil it, but Birmingham should make the scientific the principal department, the classical the subsidiary. If Birmingham were to adopt the policy suggested, taking our Cornell University as its model, where the scientific has won first place in the number of students, and give degrees in science as in classics, I should be delighted to contribute the last £50,000 of the sum you have set out to raise, to establish a scientific department. I am sure our people of the Birmingham across the Atlantic will heartily approve this gift to their prototype on this side of the water, for what does not the younger owe of its greatness and prosperity to the old land. Bessemer, Siemens, Thomas—the triumvirate through whose inventions we have been enabled to make and sell steel by the millions of tons at three pounds for a penny—all made their experiments in your midst. Let the gift, therefore, be considered as only a slight acknowledgment of a debt which Pittsburgh, the greatest beneficiary of your steel inventions, can ever hope to repay.

Wishing you speedy success, sincerely yours,

ANDREW CARNEGIE.

WE learn from *The British Medical Journal* that a grand *festa* has been held in Reggio, Emilia, in honor of the first centenary of the death of Lazzaro Spallanzani, who was born at Scandiano, in Modena, January 12, 1729, and died at Pavia, February 12, 1799. Spallanzani studied at Bologna, took holy orders, and in 1775 was elected professor of logic, Greek and rhetoric at Reggio. Among his works are: *Le osservazioni microscopiche sulla teoria della generazione di Needham e Buffon*, in which he defended the doctrine of biogenesis against those authors; and *Dei fenomeni della circolazione* and *Memorie sulla respirazione*. Spallanzani was the first who saw the circulation of the blood of warm-blooded animals under the microscope. He made use

of the hen's egg during the development of the chick.

INQUIRIES as to the schools in which leading men in various professions were educated have been made by *The School World*, and the results for men of science are abstracted in *Nature*. Of 250 representative men of science—mostly Fellows of the Royal Society—chosen for the present inquiry, one-fifth received their early education either in private schools or at home under tutors. The schools which claim the greatest number of old pupils in the selected list are Edinburgh High School, Edinburgh Academy and Aberdeen Grammar School. The Scotch schools are followed, as regards the number of old pupils of distinguished eminence in science, by the City of London School and King's College School. Eton, Harrow and Rugby succeed these, and are in turn followed by Liverpool College, Royal Institution School (Liverpool) and St. Paul's. The remarkable point brought out by this comparison, says *Nature*, is the small part the great public schools have taken in training the leaders in science of the present day. When the men who are now in the foremost rank among philosophers were receiving their early education science was almost, if not quite, omitted from the public school curriculum, with the result that comparatively few boys from such schools have become eminent in the scientific world. The neglect of science in comparison with other subjects is shown by the fact that Eton, Harrow, Rugby, Winchester, Westminster and one or two other public schools, though comparatively poor in their scientific record, are shown to have furnished the greatest number of leading men in Parliament, the church and the law, Eton leading the way as regards numbers in each of these classes.

THE Regents of the University of the State of New York have voted that the Secretary be authorized to sell any of the University publications at half price to any university institution or to any teacher or officer of such institution, and to give such publications outright to such depositories as shall be registered as entitled to such consideration because they agree to preserve and catalogue the publications and make them

available for public use. Pamphlet editions of the reports giving administrative details and information as to the workings of the department may be given away; but scientific contributions of the museum staff and other valuable matter printed as appendices to the reports, and the bound volumes containing such matter, shall not be for free distribution, but shall be sold at a nominal price approximately covering cost of paper, presswork and binding.

UNIVERSITY AND EDUCATIONAL NEWS.

IN addition to Professors Picard, Mosso and Ramón y Cajal, whom we have already announced as lecturers at the decennial celebration of Clark University, to be held July 5th to 8th, we are informed that Dr. Ludwig Boltzmann, professor of theoretical physics at the University of Vienna, and Dr. August Forel, formerly professor of psychiatry at the University of Zurich, will give short courses of lectures.

MR. B. H. DUKE has made an additional gift of \$50,000 to Trinity College, at Durham, N. C.

THE degree of Bachelor of Science has been given to 170 candidates by the Massachusetts Institute of Technology.

It is reported that nine professors at St. Petersburg University have resigned as an expression of sympathy with the grievances of the students.

THE Rev. William H. P. Faunce, D.D., pastor of the Fifth Avenue Baptist Church, New York, has accepted the presidency of Brown University.

DR. D. J. BIEHRINGER and Dr. Tröger have been promoted to assistant professorships of chemistry in the Institute of Technology at Braunschweig. Dr. Abegg has qualified as docent in physical chemistry in the University of Breslau; Dr. Schultze in zoology in the University at Jena; Dr. Kowalevsky in mathematics in the University of Leipzig; Dr. Feitler in physical and theoretical chemistry in the Institute of Technology at Vienna; Dr. von Oppolzer in astronomy and astrophysics in the German University at Prague, and Dr. Relstab in physics in the Institute of Technology at Braunschweig.

SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; J. LE CONTE, Geology; W. M. DAVIS, Physiography; HENRY F. OSBORN, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; J. MCKEEN CATTELL, Psychology; DANIEL G. BRINTON, J. W. POWELL, Anthropology.

FRIDAY, JUNE 23, 1899.

CONTENTS:

<i>United States Naval Observatory</i>	857
<i>The Diffraction Process of Color Photography:</i> PROFESSOR R. W. WOOD.....	859
<i>The Mental Fatigue due to School Work:</i> DR. EDWARD THORNDIKE.....	862
<i>The International Catalogue of Scientific Literature:—</i>	
Physics: PROFESSOR J. S. AMES.....	864
Chemistry: DR. H. CARRINGTON BOLTON and WILLIAM P. CUTTER.....	867
Meteorology: PROFESSOR CLEVELAND ABBE ..	871
<i>The Stokes Jubilee</i>	872
<i>Scientific Books:—</i>	
<i>Poynting and Thomson on Sound:</i> PROFESSOR W. LE CONTE STEVENS. <i>Cole on Photographic</i> <i>Optics:</i> DR. FRANK WALDO. <i>Books Received.</i>	872
<i>Societies and Academies:—</i>	
<i>The Science Club of the University of Wisconsin:</i> PROFESSOR WILLIAM H. HOBBS. <i>Torrey Botanical Club:</i> EDWARD S. BURGESS. <i>Zoological Club of the University of Chicago</i>	875
<i>Discussion and Correspondence:—</i>	
Totemism: HIRAM M. STANLEY. <i>Arousal of an Instinct by Taste Only:</i> DR. E. W. SCRIPTURE.	877
<i>Current Notes on Meteorology:—</i>	
<i>Influence of the Great Lakes on Precipitation; Report of the Chief of the Weather Bureau; Jamaica Weather Service; New Daily Weather Maps; Winter Temperatures at Dawson City; Recent Publications:</i> R. DEC WARD.....	878
<i>Botanical Notes:—</i>	
<i>The Varieties of Corn; The Agricultural Grasses of Kansas; Diseases of the Sweet Potato:</i> PROFESSOR CHARLES E. BESSEY.....	880
<i>The American Association for the Advancement of Science</i>	882
<i>The Centenary of the Royal Institution</i>	882
<i>Scientific Notes and News</i>	884
<i>University and Educational News</i>	887

* MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

UNITED STATES NAVAL OBSERVATORY.

ASTRONOMERS everywhere will be gratified by the announcement from Washington that Secretary Long has appointed a board to visit, examine and report upon the U. S. Naval Observatory. The work of this body will be of such far-reaching importance—perhaps determining the character of our government astronomy for fifty years to come—as to make it worthy of the serious consideration of the public. Whether it shall prove as nugatory as the efforts heretofore made to improve the administration must depend upon the wisdom with which the board executes its difficult and delicate task.

We believe a grave mistake will be made if the board confines itself to matters of detail and merely points out the features in which the administration can be improved. We have had plenty of such criticism in the past and always without any important result. The subject should be approached from a broader point of view, taking in its scope the whole history of the institution, past and prospective. What we are concerned with are the work and results of the most richly endowed and liberally supported astronomical observa-

tory in the world. The funds for its support come from the pockets of our taxpayers, and the latter, speaking through our astronomers as their mouthpiece, should be satisfied with nothing less than that the work done by the institution shall correspond to the liberality with which they are supporting it. The fact that our country has a larger proportion of the ablest astronomers of the world than any other, not excepting even Germany, leaves us without any excuse if our national observatory fails to be completely up to the present time.

For more than fifty years we have been trying an experiment in astronomical administration which no other nation ever thought of trying and which we ourselves have never tried in any other field, that of managing a great national observatory like a naval station. One of the most important questions is whether this experiment, taking the whole fifty years together, can be called a success. This question can be answered only by a critical examination of the work of the institution, as found in its volumes of published observations and official reports. In this connection it will be wise to review the laudable efforts made from time to time to improve the administration and determine the causes of their success or failure.

When the subject is considered from this point of view it is a serious question whether any other than an adverse conclusion can be reached. It is true that excellent work has now and then been done at the observatory and that this, taken in connection with the favorable impression made by the splendor of its new buildings, prepossesses

the public, which never looks below the surface in its favor. But, as was very clearly pointed out by the National Academy of Sciences in a report in 1885, this good work has been mostly the voluntary work of individuals who happened to be attached to the institution and acted on their own initiative. The part of the administration was only to get the men together and procure them facilities for work.

It should also be remembered that even this work is not by any means a permanent feature of the institution. If we take away from the latter such work as that of Seers Cook Walker in investigating the motions of Neptune, and of Professor Asaph Hall in discovering the satellites of Mars and in investigating the motions of other satellites, what have we left? If anything but a heterogeneous collection of observations and researches, sometimes intermitted entirely and sometimes carried on with vigor, sometimes devoted to one object, sometimes to another, sometimes able and sometimes useless, generally of the most perfunctory kind, nearly always with more or less imperfect instruments and with little evidence of any concerted plan, we hope the board will find it out.

An excellent text will be found in the recent catalogue of stars by Professor Eastman, which, we are told in the preface, has occupied two-thirds of the observatory force for a period of more than thirty years. What should the committee say when it compares the unflagging zeal and persistence of the author with the imperfections of the instrument he had to use?

In the same class may come the more re-

cent work of Professor George A. Hill with the prime vertical transit. There can be no question of the zeal and industry with which Mr. Hill has for five years continued a series of observations bearing on one of the most important problems in exact astronomy with which we are dealing to-day. Yet the results of his work so far as published show now and then anomalies and irregularities leading to the suspicion that there is something wrong about the instrument. The cause can be found only by critical investigation. It would certainly be very regrettable if such rare qualities as those of Mr. Hill should fail to be productive of their best results through adverse circumstances which would be speedily remedied under a proper system of administration; and we hope the Committee will either demonstrate that the suspected defects of the work are unreal, or show their cause if they exist.

THE DIFFRACTION PROCESS OF COLOR
PHOTOGRAPHY.

THE production of color by photography has been accomplished in two radically different ways up to the present time. In one, the so-called Lippman process, the waves of light form directly in the photographic film laminæ of varying thickness, depending on the wave-length or color of the light. These thin laminæ show interference colors in reflected light in the same way that the soap bubble does, and these colors approximate closely the tints of the original. The technical difficulties involved in this process are so great that really very few satisfactory pictures have ever been made by it. The other, or three-color process, has been developed along several distinct lines; the most satisfactory results having been produced by Ives with his

stereoscopic 'Kromskop,' in which the reproduction is so perfect that in the case of still-life subjects it would be almost impossible to distinguish between the picture and the original seen through a slightly concave lens. The theory of the three-color method is so well known that it will be unnecessary to devote any space to it, except to remind the reader of the two chief ways in which the synthesis of the finished picture is effected from the three negatives. We have, first, the triple lantern and the Kromscope, in which the synthesis is optical, there being a direct addition of light to light in the compound colors, yellow being produced, for example, by the addition of red and green. The second method is illustrated by the modern trichromatic printing in pigments. Here we do not have an addition of light to light, and, consequently, cannot produce yellow from red and green, having to produce the green by a mixture of yellow and blue. Still a third method, that of Joly & McDonough, accomplishes an optical synthesis on the retina of the eye, the picture being a linear mosaic in red, green and blue, the individual lines being too fine to be distinguished as such.

The diffraction process, which I have briefly described in the April number of the London, Edinburgh and Dublin *Philosophical Magazine*, is really a variation of the three-color process, though it possesses some advantages which the other methods do not have, such as the complete elimination of colored screens and pigments from the finished picture, and the possibility of printing one picture from another. The idea of using a diffraction grating occurred to me while endeavoring to think of some way of impressing a surface with a structure capable of sending light of a certain color to the eye, and then superposing on this a second structure capable of sending light of another color, without in any way

interfering with the light furnished by the first structure. This cannot, of course, be done with inks, since if we print green ink over red the result will not be a mixture of red light and green light, but almost perfect absence of any light whatever; in other words, instead of getting yellow, we get black. Let us consider, first, how a picture in color might be produced by diffraction. Place a diffraction grating (which is merely a glass plate with fine lines ruled on its surface) before a lens, and allow the light of a lamp to fall upon it. There will be formed, on a sheet of paper placed in the focal plane of the lens, an image of the lamp flame, and spectra, or rainbow-colored bands, on each side of it. Now, make a small hole in the sheet of paper in the red part of one of these spectra. This hole is receiving red light from the whole surface of the grating; consequently, if we get behind the paper and look through the hole we shall see the grating illuminated in pure red light over its whole extent. This is indicated in Fig. 1, where we have the red

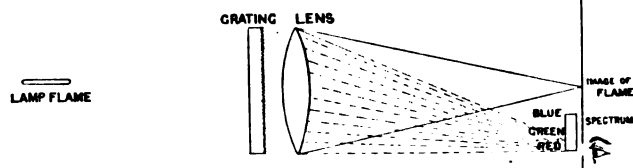


FIG. 1.

end of the spectrum falling on the hole, the paths of the red rays from the grating to the eye being indicated by dotted lines. Now, the position of the spectra, with reference to the central image of the flame, depends on the number of lines to the inch with which the grating is ruled. The finer the ruling the farther removed from the central image are the colored bands removed. Suppose, now, we remove the grating in Fig. 1, and substitute for it one with closer ruling. The spectrum will be a

little lower down in the diagram, and, instead of the red falling on the hole, there will be green; consequently, if we look through the hole we shall see this grating illuminated in green light. A still finer ruling will give us a grating which will appear blue. Now, suppose that the two first gratings be put in front of the lens together, overlapping, as shown in Fig. 2. This

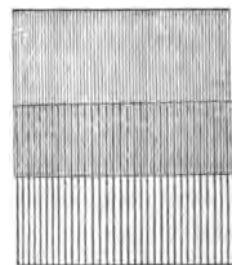


FIG. 2.

combination will form two overlapping spectra, the red of the one falling in the same place as the green of the other, namely, on the eye-hole. The upper strip, where we have the close ruling, sends green light to the eye and appears green; the under strip, with the coarser ruling, sends red light to the eye and appears red; while the middle portion, where we have both rulings, sends both red and green light to the eye, and in consequence appears yellow, since the simultaneous action of red and green light on any portion of the retina causes the sensation of yellow. In other words, we have, in superposed diffraction gratings, a structure capable of sending several colors at once to the eye.

If we add the third grating we shall see the portion where all three overlap illuminated in white, produced by the mixture of red, green and blue light.

Three gratings, with 2,000 lines, 2,400 lines and 2,750 lines to the inch, will send red, green and blue light in the same di-

rection, or, in other words, to the same spot on the screen behind the lens.

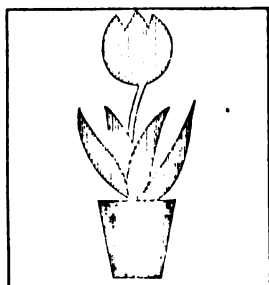


FIG. 3.

Suppose, now, we have a glass plate with a design of a tulip, with its blossom ruled with 2,000 lines to the inch, its leaves ruled with 2,400 and the pot in which it is growing ruled with 2,750 lines, and place this plate before the lens. On looking through the hole we shall see a red tulip with green leaves growing in a blue pot. Thus we see how it is possible to produce a colored picture by means of diffraction lines, which are in themselves colorless. Those portions of the plate where there are no lines send no light to the eye and appear black.

We have, now, to consider how this principle can be applied to photography. That photographs which show color on this principle can be made depends on the fact that a diffraction grating can be copied by contact printing in sunlight on glass coated with a thin film of bichromated gelatine. The general method which I have found best is as follows. Three gratings ruled on glass with the requisite spacing were first prepared.* To produce a picture in color, three negatives were taken through red, green and blue color filters in the usual manner. From these three ordinary lantern-slide positives were made. A sheet of thin plate glass was coated with chrom gelatine, dried, and cut up into pieces of

*These gratings were ruled for us on the dividing engine at Cornell University, through the courtesy of Professor E. L. Nichols.

suitable size; one of these was placed with the sensitive film in contact with the ruled surface of the 2,000-line grating, and the whole covered with the positive representing the action of the red light in the picture. An exposure of thirty seconds to sunlight impressed the lines of the grating on the film in those places which lay under the transparent parts of the positive. The second grating and the positive representing the green were now substituted for the others and a second exposure was made. The yellows in the picture being transparent in both positives, both sets of lines were printed superposed in these parts of the picture, while the green parts received the impression of 2,400 lines to the inch only.

The same was done for the blue, and the plate then washed for a few seconds in warm water. On drying it appeared as a colored photograph when placed in front of the lens and viewed through the hole in the screen. Proper registration during the triple printing is secured by making reference marks on the plates. A picture of this sort once produced can be reproduced indefinitely by making contact prints, since the arrangement of the lines will be the same in all of the copies as in the original. The finished picture is perfectly transparent and is merely a diffraction grating on gelatine with variable spacing. In some parts of the picture there will be a double grating, and in other parts (the whites) there will be a triple set of lines. Having had some difficulty in getting three sets of lines on a single film in such a way as to produce a good white, I have adopted the method of making the red and green gratings on one plate and the blue on another, and then mounting the two with the films in contact. It is very little trouble to multiply the pictures once the original red-green grating picture is made.

The pictures are viewed with a very simple piece of apparatus shown in Fig. 4,

consisting of a lens cut square like a reading glass, mounted on a light frame provided with a black screen perforated with an eye hole through which the pictures are viewed.

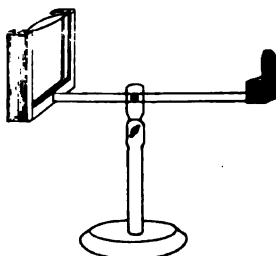


FIG. 4.

The colors are extremely brilliant, and there is a peculiar fascination in the pictures, since, if the viewing apparatus be slowly turned so that its direction with reference to the light varies, the colors change in a most delightful manner, giving us, for example, green roses with red leaves, or blue roses with purple leaves, a feature which should appeal to the impressionists. The reason of this kaleidoscopic effect is evident, for, by turning the viewing apparatus, we bring the eye into different parts of the overlapping spectra.

It is possible to project the pictures by employing a very intense light and placing a projecting lens in place of the eye behind the perforation in the screen. Of course, a very large per cent. of the light is lost; consequently great amplification cannot well be obtained. I have found that sunlight gives the best results, and have thrown up a three-inch picture on a four-foot sheet, so that it could be seen by a fair-sized audience.

By employing a lens of suitable focus it is possible to make the viewing apparatus binocular, for similar sets of superposed spectra are formed on each side of the central image by the gratings, so that we may have two eyeholes if the distance between the spectra corresponds to the interocular distance.

It is interesting to consider that it is theoretically possible to produce one of these diffraction pictures directly in the camera on a single plate. If a photographic plate of fine grain were to be exposed in succession in the camera under red, green and blue screens, on the surfaces of which diffraction gratings had been ruled or photographed, the plate on development should appear as a colored positive when seen in viewing apparatus. I have done this for a single color, but the commercial plates are too coarse-grained to take the impression of more than a single set of lines. With specially-made plates I hope to obtain better results.

R. W. WOOD.

UNIVERSITY OF WISCONSIN.

THE MENTAL FATIGUE DUE TO SCHOOL WORK.

THE meaning of the results obtained by the different investigators of fatigue among school children has been much confused because either the experimenter has not proved that what he measured was fatigue at all or has so arranged his experiments that the influence of practice on the one hand, and of unwillingness and lack of interest on the other, have not been discounted. Especially when, as has so often been the case, the teacher gives the work as a part of the school routine one may be measuring only a conventional habit of the school children of doing less at a certain time of day, or an unwillingness to work due to ennui. What a person *does* do need not be a measure of what he *could* do.

The experiments a summary of which follows were devised in order to get an answer to the question: "Does the work of a school-session fatigue the pupils mentally, make them really less able to do mental work than they were at its commencement, and, if so, to what extent?"

The method was to give to a sufficient

number of scholars a certain test which would measure their ability (in a certain direction, at least) to do mental work, early in the school session, and then to give this same test to a *different* lot of children of approximately equal general maturity and ability late in the session. The influence of practice is thus entirely obviated, as the scholars do not have the same sort of work twice. In order to save the results from being vitiated by differences in the general ability of the students, four different tests were used, and the pupils who had two of these tests early had the other two late, while those who had the first two late had the other two early. The influence of possible differences in the average ability of the two sets of students can thus be estimated. In order to make sure that the willingness and interest of the pupils was a constant except in so far as due to causes outside our control, all the tests were given by myself.

The work given was: (1) a set of multiplication examples to be done in a given time; (2) a page of printed matter full of mis-spelled words which were to be marked in a given time; (3) two sets of nonsense syllables to be written from memory after a ten seconds' look at them, and (4) two sets of figures and one set of simple forms (*e. g.*, square, triangle) to be written from memory in the same way.

About 150 children (four classes) were given 1 and 3 early and 2 and 4 late. An equal number of children in the same school grade were given 2 and 4 early in the school day, the other half late. In order to eliminate the influence on the work which excitement at my first visit, or being used to me or being tired of me at my second visit, might cause, I made my first visit coincide with an early test in half the classes and with a late test in the other half. The early tests were all given between 10 minutes and 40 minutes after the opening of school in

the morning, while the late tests were given between 40 minutes and 10 minutes before the close of school, half of them at the close of the morning and half at the close of the afternoon session.

Thus any general decrease in the amount or accuracy of the late work will be due to mental fatigue, or to some aversion to work caused by the school day and quite apart from the aversion to conventional routine work or to some factors yet to be demonstrated. And if there is no difference we can say with assurance that the day's work has not decreased the child's ability to work, that though he may in school do less in the latter part of the day it is not in any wise due to real exhaustion, to a lowering of his mental energy.

As a fact what difference there was between the early and late work was in favor of the *latter*. The multiplication test was given to 152 scholars early and 144 late. After reducing the amount done and mistakes made by the 152 to what would have been done by 144, and comparing the results obtained with the work of the 144 who had the test late, we find that the latter did nearly 14% more work and made less than 5% more mistakes.

The spelling work was given to 152 pupils early and 146 late. After estimating the work of 146 early pupils on the basis of what the 152 did and comparing with the 146 late, we find that the latter worked through $99\frac{7}{10}\%$ as many lines, marked about 2% more words and marked $2\frac{6}{10}\%$ more words which should have been left unmarked.

The nonsense syllables were used with 152 pupils early and 148 pupils late. When reduced to an equality in numbers the late pupils did $97\frac{6}{10}\%$ as well as the early.

The figures to be remembered were given to 152 pupils early and 145 late. When reduced to an equality in numbers the late pupils did 89% as well as the early.

In remembering the simple forms the late pupils did $94\frac{6}{10}\%$ as well as the early.

It seems clear that the mental work of the school day does not produce any marked decrease in the ability to do further work. The data here given are somewhat influenced by certain factors, though not by practice. These factors will be fully discussed in a later report.

The multiplication, spelling and figure tests when given to about 300 children in another city showed the following results:

The multiplication test was given to 156 children early and to 154 later. When evaluated for 153 children the results show the latter to have done $86\frac{3}{4}\%$ as much work, to have made $14\frac{7}{10}\%$ more mistakes. Taking together the work of all the children tested (594, 297 early, 297 late), we find that the children who did the work late did $2\frac{2}{10}\%$ more work, and made exactly the same number of mistakes.

The spelling test was given to 135 early and 128 late. When evaluated for 127 children the results show the latter to have worked through $92\frac{7}{10}\%$ as many lines, to have marked $\frac{9}{10}$ of 1 % more words, and to have marked wrongly 87 % as many words. Taking together the work of all the children tested, we find that those who did the work late worked through $94\frac{2}{10}\%$ as many lines, marked $1\frac{5}{10}\%$ more words and marked wrongly $93\frac{7}{10}\%$ as many.

The figure test was given to 156 children early and to 152 late. After reducing the results of the 156 to a basis of 152 we find that those who had the tests late did 17 % better.

Taking together the work of all the children tested, we find that those who had the test late did almost 2 % better than those who had it early.

Besides these three tests, which are of the same sort as some of those given to the first lot of children, there was given to this second lot a test with letters similar to the

figure test. This test was given to 140 children early and to an equal number late. Those doing the work late did 97 % as well as those who had it early.

The factors mentioned as influencing the work of the first set of children were largely counterbalanced by factors at work in the second; one, however, should be mentioned. A certain circumstance probably lessened the work of one class (of 30) of the first lot of children during an early spelling test. So the early work in this test should probably be reckoned about 2 % higher. On the whole these additional data render more probable our previous conclusion that "the mental work of the school day does not produce any decrease in the ability to do mental work." A glance at the following table, which summarizes the more important data, shows this better perhaps than the detailed accounts already given.

Test.	No. of Scholars Tested.	Ratio of Late to Early Work.
Multiplication.	297	$102\frac{2}{10}\%$
Spelling.	273	$101\frac{3}{10}\%$
Figures.	295	102 %
Nonsense syllables.	147	98 %
Form.	145	$94\frac{6}{10}\%$
Letters.	140	99 %

EDWARD THORNDIKE.

WESTERN RESERVE UNIVERSITY,
CLEVELAND, OHIO.

THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.

PHYSICS.

THE plan proposed is to issue a book catalogue once in five years, arranged according to both subjects and authors, and to issue also, from week to week, two sets of card catalogues—one according to subjects and the other according to authors. Estimates are given of the proposed cost of this; and various alternatives are proposed, such as the issuing of a book catalogue by itself, or a book catalogue and an author card catalogue. It is estimated that each arti-

cle will require four entries, on an average one according to the author, the others according to the subjects treated of in the paper.

It is proposed also to print, at the head of each of the cards or slips, distinctive symbols to indicate the science and particular sub-division of the science to which the paper refers.

There can be no doubt but that, to satisfy the needs of workers in laboratories, the plan of having a card catalogue of subjects is by far the most satisfactory. A book catalogue would be practically useless except to a student looking up references for historical reasons, and should, therefore, be kept in a general library, and not in a laboratory library. For the use of workers in laboratories the subject card catalogue would be of the greatest importance, as everyone knows who has ever kept one. It is of great use to the director of the laboratory in the saving of time and brain matter, because he no longer needs to remember all articles which have appeared, and to the student or investigator in keeping him informed of all that is going on in his particular line of work. From the standpoint, then, of Physics there can be no doubt but that it would be desirable for the International Committee to print all three catalogues, the book catalogue and the two card catalogues; and of these the card catalogues should be kept, it seems best, in the laboratory itself, or at least in such a situation as to be ready for use by all the students.

No suggestions are asked by the Committee concerning the division of the sciences or the classification proposed; and, in fact, this matter is of secondary importance. The plan is to have the assistants and the clerks in the Central Office in London make a division of the titles according to subjects and to label the cards and slips in some definite way; so that anyone, although ignorant of the subject-matter, can arrange

the cards easily and quickly when they are received.

Each card in Physics is to be marked with the letter 'D,' and each subject card is to have, further, a number, such as '5410,' which signifies the particular sub-division to which the subject has reference. In this particular case the 5 would indicate the primary division, 'Light'; the 4 the sub-division, 'Polarization'; the 10 the special subject, 'Methods of Producing Polarized Radiation.'

According to this system Physics is divided into seven 'primary divisions,' so-called, namely: Bibliography and Dynamics; Heat; Mechanical and Thermal Effects of Contact and Mixture; Vibrations, Waves and Sound; Theories of the Constitution of the Ether and of Matter; Light, including Invisible Radiation; Electro-magnetism.

'Bibliography and Dynamics' is subdivided into seven sections: Bibliography of Physics; Dynamics in General; Dynamics of a Particle and Rigid Dynamics; Elasticity; Hardness, Friction and Viscosity; Dynamics of Fluids; Measurements of Dynamical Quantities.

'Heat' is divided into seven sections: Temperature and Thermometry; Calorimetry; Determination of the Mechanical Equivalent of Heat; Fundamental Laws of Thermodynamics; Thermal Conduction and Convection; Changes of Volume and of State (Experiment and Theory); Radiation.

'Mechanical and Thermal Effects of Contact or Mixture' is divided into five sections: Friction; Capillarity; Diffusion; Transpiration and Mechanical Permeability; Imbibition and Surface Condensation of Gases; Solution and Osmose.

'Vibrations, Waves and Sound' is divided into five sections: Theory and Observation of Harmonic Vibrations; Theory of Wave Motion; Sound; The Sensation of Sound; The Physical Basis of Music.

'Light, including Invisible Radiation,' is divided into six sections: Geometrical Optics and Photometry; Velocity, Wave-length, Energy, etc., of Radiation; Interference and Diffraction; Reflection and Refraction; Polarization; The Emission of Radiation, Phosphorescence, etc.

'Electro-magnetism' is divided into eight sections: Electric and Magnetic Units; Electrostatics; Magnetism; The Electric Current; Electrolysis; Electrodynamics; Electric Discharge; Terrestrial Magnetism; The Compass, Earth Currents.

These sections are divided further into 270 sub-divisions. The cards are to go to the subscribers fully labelled, the marking being done by expert assistants in London. On being received they can be filed away in suitable cases by a clerk, no expert knowledge being required. With a suitable key as to symbols any desired reference can be found quickly, and the work being done in any subject can be ascertained easily. Any system of classification, therefore, which is extensive, definite, and free from ambiguity, will be satisfactory.

In the main, the systems proposed by the Committee of the Royal Society are most satisfactory; and the labor expended in perfecting them in the different sciences, although enormous, will be fully repaid.

Unfortunately, the classification in Physics does not entirely satisfy the requirements demanded. The primary divisions are not altogether logical, nor is the classification of certain subjects; but this is comparatively immaterial.

In some cases it would undoubtedly be well still further to sub-divide a subject. For instance, the sub-division devoted to the 'discharge in rarefied gases,' or the one devoted to the 'measurements of wave-lengths by optical and photographic methods.' In other cases this process has been carried too far. For instance, there is no particular reason why a special sub-division should be

given to the 'vapor pressure near curved surfaces.'

Again, certain subjects seem to be entirely omitted, such as 'spectrum analysis;' the 'effect of different external causes on wave-lengths,' such as the Zeeman effect and the pressure effect; the 'numerical relations between the lines of any one spectrum and between the spectra of different elements;' 'Döpler's principle;' the 'laws of radiation and absorption;' 'forced vibrations and resonance;' the 'laws of steady currents as distinct from alternating currents;' 'heat effects of currents;' 'photography;' etc.

There are sections which are almost identical, such as the 'vibration of strings and rods' under 'Sound' and the 'dynamics of flexible strings' under 'Elasticity.' It is hardly an accepted fact that the Hall effect is due to changes in specific resistance, and, therefore, one would not necessarily, place it in that section. Again, in speaking of dynamics, the word center of inertia or center of mass is preferable to center of gravity. The name 'Electro-magnetism' is not a particularly happy one for the last primary division.

The only points of importance in the classification which need be criticised, however, are, I think, the omissions, the other matters being of very little importance, owing to the fact that the classification has a key, and the fact that anyone can, therefore, easily find the reference which he desires. It would increase, however, the value of the catalogue if the scheme of classification could be somewhat remodeled, and I venture to express the hope that some action of this kind may be taken before the recommendations of the committee are accepted by the countries concerned in the proposal.

There has been no plan proposed in recent years which seems to be of so great importance to the students of Physics

throughout the world as this, and it is earnestly to be desired that enough countries and enough universities and libraries will subscribe to the enterprise to make it possible for the Central Committee to publish the book and the card catalogues.

J. S. AMES.

JOHNS HOPKINS UNIVERSITY.

CHEMISTRY.

If the object of arranging titles of books in a bibliography in certain groups or classes is to enable readers and investigators to find more readily an article on a given subject, then the *anonymous* Committee that drew up the schedule of classification for Chemistry in the Report of the Royal Society's International Catalogue Committee has made an almost total failure.

Two methods were open to the Committee appointed to devise a classification scheme for Chemistry, either to adopt an arbitrary system, in which symbols uniformly indicate definite subjects, or to adopt the dictionary plan, in which specific words are arranged alphabetically. The latter plan has, in our opinion, great and incontestable advantages over the former, but as the Committee chose to adopt the first named method the second cannot be here considered.

The provisional plan which was submitted to the delegates at the Conference of the International Catalogue Committee, held in London, October, 1898, forms Section F, of the general scheme printed in a small volume, very difficult for others than delegates to obtain. The grand divisions, with their registration symbols, are as follows:

(No number) Chemical Bibliography.

0100 Chemistry (Specific) of the Elements.

0000 Laboratory Procedure.

1000 Organic (Carbon) Chemistry (Specific).

1010 Hydrocarbons.

1100 Alcohols and Ethers.

1200 Acids.

1300 Aldehydes and Ketones.

1400 Carbohydrates; Glucosides; Resins.

1500 Amino- and Azo-Compounds.

1600 Mixed Cycloids.

1700 Organo-Metallic and allied Compounds.

1800 Alkaloids.

1900 Proteids.

2000 Coloured Compounds.

2500 Operations in Organic Chemistry.

3000 Analytical Chemistry.

3500 Theoretical and Physical Chemistry.

4000 Physiological Chemistry.

These grand divisions are sub-divided so as to provide a class and a symbol for every substance known to the chemist or awaiting discovery; at least such is the intention. Chemical Bibliography is divided into six groups, to wit:

0000 Philosophy.

0010 History.

0020 Biography.

0030 Dictionaries, collected works, monographs, and text-books.

0040 Pedagogy.

0050 Addresses, lectures, essays and theses.

Curiously, no symbol is provided for bibliographies of chemistry, a topic that must have been prominent in the minds of the persons on the Committee.

The second grand division '0100 Chemistry of the Elements' is intended to embrace "all specifically chemical subject-matter, and such other entries as may be desirable, relating to the elements generally, excepting carbon." In this category the elements are arranged alphabetically and to each a symbol is given, thus:

0110 (Al) Aluminium.

0120 (Sb) Antimony.

0130 (A) Argon.

* * * * *

0200 (Cd) Cadmium.

0210 (Cs) Cesium.

* * * * *

0250 (Cl) Chlorine.

0260 (Cr) Chromium.

* * * * *

0300 (Va) Vanadium.

0310 (Yt) Ytterbium.

0320 (Y) Yttrium.

0330 (Zn) Zinc.

0340 (Zr) Zirconium.

Students, and even older chemists, who find difficulty in recalling the atomic weights of common elements will scarcely welcome the proposition to give to each element another factor, though in the case of antimony this objection disappears.

This alphabetical arrangement of the elements prevents carrying out one of the prime objects of classification, namely, the grouping of related matters; thus

0270 = Cobalt, 0500 = Nickel,
0000 = Sulphur, 0710 = Tellurium.

The natural group Ba, Ca and Sr, have respectively the unrelated numbers 0150, 0220 and 0680. Surely the elements might have been arranged systematically, so that related bodies would have contiguous symbols.

Annexed to the table of elements are instructions for sub-dividing entries and the following paragraph: "Specific entries relating to the halogens collectively shall be arranged in Division 0250 under *Halogens*." This mixing of a word-heading with numerical symbols is a weak feature to be again noticed.

The instructions for entering titles in sub-divisions of 0100 include the following paragraph: "Entries relating to compounds, which in the Slip Catalogue bear the number and symbol of the dominant element, together with the symbol of the secondary constituent, or dominant second constituent, shall be printed in the sub-division of their second constituent." If we understand aright this rather obscure sentence, it provides for writing on slips according to one rule and for printing them in book-form according to another rule; sodium chloride would appear, therefore, under the symbol for sodium in the written slips and under chlorine in the printed volume!

A second paragraph provides that "references to hydroxides, acids and salts shall be entered under the oxide, and corre-

sponding sulphur compounds under the sulphide."

A third paragraph reads as follows: "(d) In each sub-division the entries shall be arranged in such order that those relating, α , to the history or origin of the substance come first, and following these, in the order mentioned, those relating, β , to its preparation or manufacture; γ , to its structure, or of a theoretical nature; δ , to its interactions or use; ϵ , to its compounds—these five several sections being denoted by the letters α , β , γ , δ , ϵ ."

Passing without comment this non-parsable English (which occurs elsewhere in the report), the scheme introduces another arbitrary feature, Greek letters for specific subjects, which is an admission that the numerical plan is found insufficient; though it need not be, provided decimals were used, a plan which does not seem to be contemplated by the Committee. The suggestion is even made that "it would be possible to carry the analysis still farther by means of symbols, such as ψ , z , and so forth, to indicate physical properties, crystalline form, etc." The writers of this review venture to suggest that when the Greek alphabet is exhausted the Hebrew will come in handy.

This mixture of numerical symbols with word-headings is again resorted to in division '0930 Operations in inorganic chemistry,' where it is suggested that "entries shall be made under significant headings, such as dissolution (*sic*) and solvents, crystallization, distillation, * * * oxidation, electrolysis, furnace operations, etc., arranged alphabetically."

To organic chemistry the symbol 1000 is assigned, under which all entries shall be arranged that relate to the subject generally; substitution derivatives of the compounds included in each of the numbered divisions—especially haloid and allied derivatives—shall, as far as possible, be en-

tered under the compounds from which they are derived.

The next paragraph provides that "entries under the name of a substance may, if necessary, be sub-divided in the same way as that proposed for inorganic substances."

Hydrocarbons receive the numerical symbol 1010, and the scheme for indicating their substitution derivatives leads to amazing propositions; the general group is divided thus:

1010 Hydrocarbons.

1020 Paraffins.

1000 Unsaturated Open-Chain Hydrocarbons.

1040 Benzenoid Hydrocarbons.

1050 Reduced Benzenoid Hydrocarbons (Terpenes, etc.).

1000 Unclassified Hydrocarbons.

"Each of these divisions shall be sub-divided (excepting 1010 and 1020) into isologous groups, in each of which compounds shall be entered in homologous order." Then follow two new arbitrary signs for distinguishing derivatives; these are full-faced numerals, 2, 4, etc., used to indicate homologous series C_nH_{2n-2} , C_nH_{2n-4} , and the full-faced letter C, with exponents attached to indicate the number of carbon atoms in a given compound.

Applying this scheme to nitropropane ($CH_3CH_2CH_2(NO_2)$) it will receive the registration symbol 1020.C₃.NO₂; allene ($C_3:C:CH_3$) will be indicated by the symbol 1030.2.C₃, and bromotoluene ($C_6H_5CH_2Br$) will be indicated by 1040.6.C₇.Br.

This plan of assigning to definite chemical bodies arbitrary symbols resembling in structure well-established formulæ is most objectionable; if carried out it would prove vexatious to chemists and of no practical value to librarians.

To alcohols and ethers the symbol 1100 is assigned; to acids, 1200; each of these groups is sub-divided exactly as are the hydrocarbons, but the symbols of the sub-divisions do not harmonize. Since paraf-

fins = 1020, 'ols' should have been 1120, and acids 1220 (instead of 1110 and 1210).

In the paragraph on acids provision is made for indicating the number of oxygen atoms, the character of the acid and the basicity by numbers, to which ol, al, on, id or cy shall be appended, according to the origin of the acid. "Thus lactic acid would be marked 1210.C₃O₃ (1.01), and protocatechuic acid, 1230.8.C₇O₄ (1.2.01)." Here, again, we have registration symbols resembling in a general way chemical formulæ, yet they do not show the constitution nor even suggest the name of the substance.

Number 1440 is given to carbohydrates other than mono-, di- and trisaccharides and 1450 to glucosides and 1460 to resins, and it is provided that compounds belonging to these divisions shall be entered alphabetically; this is again a departure from the numerical plan. Another rule provides that "under alkaloids (1800) a list shall be given of vegeto-alkaloids, together with the Latin names of the plants from which they have been obtained, arranged in the alphabetical order of the plant names." Chemists not versed in botany would find this arrangement a puzzling one. Again, "alkaloids derived from plants (1810) and from animals (1820) shall be arranged alphabetically."

Division 2000 is styled 'Coloured compounds' [!], a singular misnomer for compounds used in dyeing; yet another division, 2010, is called 'Coloured substances, not dye-stuffs,' and division 2020 is named 'dye-stuffs.' Provision is made for sub-dividing these categories thus: "2010 into Hydrocarbons (coloured), Alcohols (coloured), Ketones (coloured), etc.; 2020 into Azo dyes * * * dye-stuffs of vegetable origin, unclassified dyes," arranged alphabetically in each sub-division.

The rules concerning the entries of the sub-divisions of 3000, Analytical Chem-

istry, also lack uniformity, clearness and exactness; "division 3200 shall include all entries relating to the determination of individual elements in their compounds and in mixtures, excluding determinations of atomic weights" which belong to division 3500 (theoretical and physical chemistry). "Division 3300 shall include all entries relating to the determination of individual compounds, *e. g.*, alkaloids, carbohydrates * * * but excluding gases. If necessary gravimetric, volumetric, electrolytic, physical, etc., methods may be distinguished by letters, such as *g*, *v*, etc." "Division 3400 (Applied Analysis) shall include all entries relating to the analysis of composite materials, such as drugs, foods, soils, waters and technical products generally, arranged under appropriate significant headings."

The remaining divisions, 3500, Theoretical and Physical Chemistry, and 4000, Physiological Chemistry, must be passed; the specimens given are sufficiently numerous.

A study of this remarkable scheme of classification shows that the Committee failed to recognize the fact that classification and notation are two distinct things, and that a notation need have no relation to the character of the class to which the notation is given. To differentiate the houses in a city, street and number are given; '120 Grand Avenue' suffices to distinguish a given house, and it is not necessary to construct a symbol indicating the number of stories, the number of windows and the color of the paint in order to recognize the address.

Accompanying the schedule of classification is a specimen page giving illustrations of the way in which these rules should be applied; the examples bring out forcibly the absurdities of the conglomerate method proposed. The paper on Argon, by Lord Rayleigh and W. Ramsay, receives the Kabbalistic formula '0100. β . φ ,' but, if we

understand rightly the Committee's rules, the numerals should be 0130, which stands for argon.

An article by J. J. Sudborough and L. L. Lloyd, on 'Stereoisomerism as affecting formation of ethereal salts from unsaturated acids,' is assigned simply the number 3500; when, however, the same paper is entered under a different title, namely: 'Etherification of stereoisomeric unsaturated acids a criterion of structure,' it has the number 1200 γ ; when, on the other hand, this paper is catalogued as: 'Cinnamic and allied acids as a criterion of structure, Etherification of,' the catalogue slip must bear the symbol 1230.10.C,0, δ .

To a chemist the formula of cinnamic acid $C_6H_5.CH:CH.CO_2H$ has a definite meaning, and we protest against a system that introduces symbols, analogous in appearance, yet wholly misleading as respects the composition.

An examination of the schedule of classification of Chemistry proposed by the International Catalogue Committee shows that it consists of a medley of several methods. The system includes:

1. Numbers, full-face and inferiors, used for several distinct purposes.
2. Roman capitals, to denote component elements.
3. Roman lower-case, to denote kind of chemical process.
4. Italic letters in parenthesis, to denote basicity of acids.
5. Greek lower-case letters.
6. Word-headings arranged alphabetically.
7. Special provisions; exceptions to rules.

In 1772, at Ulm, was printed a thin octavo, having the title 'Medicinish-chymisch und alchemistisches Oraculum,' which contains a key to over two thousand symbols and kabbalistic figures found in alchemical manuscripts and books; the book is curious and instructive, as well as really serviceable to antiquarian chemists. The number

of synonyms for a given substance is large; alum has twenty-six; aqua fortis, twenty-two; mercury, thirty-eight; a pound weight, eight, and cream of tartar is credited with thirty-two; the symbols have an uncouth appearance, but are hardly more fanciful than those proposed by the Committee on the International Catalogue. Should their schedule of classification prevail, a new edition of the 'Alchemical Oracle' would soon become a necessity.

H. CARRINGTON BOLTON,
WILLIAM P. CUTTER.

METEOROLOGY.

THE schedules of classification in meteorology proposed by the International Catalogue Committee of the Royal Society seem to be fairly well adapted to secure the objects sought by the International Conference on the bibliography of science. I do not understand that the Conference or the Committee has in mind any attempt at a philosophical classification of human knowledge as embodied in the publications of scientific societies. On the contrary, their object is merely to collect together in London all possible titles of scientific works, and to so arrange these that the clerks of the Royal Society may easily copy out all the titles on any given subject that may be called for by any student or investigator. For instance, under the head of 'Earth Temperature,' No. 2,100, there may be 10,000 titles and cards; these will be subdivided into a number of divisions, probably according to special aspects and according to the countries or stations. Each of these sub-divisions may have a number between 2,100 and 2,199, or, if more sub-divisions are needed, they will be between 21,000 and 21,999. Of course, the ease with which a clerk picks out the cards that belong to a given subject desired by the student depends, first, upon the minuteness of this sub-classification, and, sec-

ondly, upon the accuracy with which the content of a memoir is expressed by its own title. This latter is the *bête noir* of all classification by titles, and there is no remedy for it except that the bibliographer examine the original memoir itself, page by page. In this respect the Royal Society must depend upon the thoroughness of those who send titles to it. The Society is simply the central office, or agent, for all the other societies and men in the scientific world. Every card that is sent to it should have inscribed on it the one or more subdivisions into which it falls. If these subdivisions do not appear on the preliminary schedules of classification that have been sent out for criticism and suggestion, then they will be inserted as fast as needed.

It seems to me that the method adopted by the Conference and the Royal Society will work just as well as any other that could be suggested, and will be a great boon to science if kept up during the next century. Of course, it will require at least ten years of experience for us to begin to appreciate either its defects or advantages. Fortunately, so far as regards meteorology, the Weather Bureau has the great international bibliography, started in 1881 under my personal supervision and already partially published. The classification adopted therein by Mr. C. J. Sawyer, after consultation with all the recognized experts of Europe and America, embraces many details not specifically mentioned in the schedule of the Royal Society, and is found very convenient when once the student has become slightly familiar with it. It endeavored to attain greater elasticity by adopting a mixture of capital and small letters, Roman and Arabic numerals, in order to designate the various divisions and sub-divisions. Thus we have IB1b to designate the Aristotelian works on meteorology in general, whereas the Royal Society classification would, undoubtedly, designate

these as 0002, or, possibly, 00021. There is very little to choose between the two methods except as to the ease in writing, speaking and printing.

As to the classification or arrangement of subjects, my personal preference would be strongly in favor of a simple dictionary catalogue.

CLEVELAND ABBE.

THE STOKES JUBILEE.

ON June 1 and 2, 1899, the University of Cambridge celebrated the fiftieth anniversary of the appointment of Sir George Gabriel Stokes to the Lucasian professorship of mathematics in that institution. During the half century of his connection with Cambridge, Professor Stokes has distinguished himself by a remarkable series of investigations in the fields of hydromechanics, physical geodesy, elasticity, the undulatory theory of light, and pure mathematics. His activity has continued down to the present date, one of his most recent papers dealing with the mechanical properties of the X-rays.

The celebration of so rare an event in academic life, and the eagerness of educational and scientific institutions to render homage to so eminent a man, naturally brought together a large body of specialists in the mathematico-physical sciences. About 400 delegates and other guests were present. Nearly all of these were entertained either in the colleges or in the homes of members of the professorial staff. Thus was it made easy for the stranger within the gates of this renowned University to see much of its inner life and to enjoy in the fullest degree its charming hospitality.

The ceremonies began on the afternoon of June 1st, with the Rede Lecture, delivered in the Senate House, by Professor Cornu, on 'The wave theory of light; its influence on modern physics.' This was delivered with admirable clearness in French. In the

evening following a *conversazione* was held in Fitzwilliam Museum, and busts of Sir George Stokes were presented to the University and to Pembroke College (that of Stokes) by Lord Kelvin.

On the morning of June 2d the delegates and guests were received in the Senate House by the Vice-Chancellor and the delegates presented the addresses sent by the various academic and scientific institutions. There were about seventy such addresses, so that it was essential to dispense with the formal reading of them in most cases. Professor Stokes responded briefly and with great modesty to these addresses, saying that they made him feel that in his long life he ought to have accomplished much more; but, he added, humorously: If I had done more I probably should not have lived to celebrate this jubilee.

On the afternoon of June 2d the address of the University of Cambridge and a gold medal were presented to Sir George Stokes; and immediately thereafter the degree of Doctor in Science, *honoris causa*, was conferred on the following distinguished men of science: Marie Alfred Cornu, professor of experimental physics in the École Polytechnique, Paris; Jean Gaston Darboux, dean of the faculty of sciences in the University of Paris; Albert Abraham Michelson, professor of experimental physics in the University of Chicago; Magnus Gustav Mittag-Leffler, professor of pure mathematics, Stockholm; Georg Herman Quincke, professor of experimental physics in the University of Heidelberg; and Woldemar Voigt, professor of mathematical physics in the University of Göttingen.

SCIENTIFIC BOOKS.

A Text-Book of Physics—Sound. By J. H. POYN-
TING and J. J. THOMSON. London, Charles
Griffin & Co. 1899. Pp. 163.

This is the first one of five volumes in

course of preparation by the authors, the others relating to 'Properties of Matter,' 'Heat,' 'Magnetism and Electricity,' and 'Light,' respectively.

These text-books are intended "chiefly for the use of students who lay most stress on the study of the experimental part of physics, and who have not yet reached the stage at which the reading of advanced treatises on special subjects is desirable." The nature of sound and its chief characteristics are first considered in a chapter that is wholly free of mathematics. The velocity of sound in air and other media is then discussed, the reflection and refraction of sound, frequency and pitch of notes, resonance and forced oscillations, the analysis of vibrations by Fourier's theorem, the transverse vibrations of stretched cords, longitudinal vibrations in pipes and other air cavities, vibration of rods, plates and membranes, the Trevelyan rocker, sensitive flames and musical sand. The last chapter is on the superposition of waves, with application to the physical basis of concord and discord, and on combination tones.

The distinguished authors are so well known for their original and accurate work as investigators that the critic who is in search of mistakes will find little to note, beyond a very small number of obvious typographical errors. In the descriptive parts the style is clear and the paragraphing is good. A majority of the illustrations are in the form of diagrams. In the mathematical parts the use of calculus is wholly avoided.

In judging the practical value of a text-book it is necessary to take into view a number of considerations which have no place in connection with what is intended for the advanced reader. Regard must be had also for differences of educational method in different countries. If instruction is given by lectures entirely the text-book is merely an accompaniment for private reading. But if the text book is to be a drill book, as is, perhaps, most frequently the case in America, and especially if much of its contents be mathematical, it will almost surely be unsatisfactory unless prepared by one who has had much experience, not merely in the art of presentation, but especially in that of

testing the student's success in acquisition. At the outset there must be a clear understanding as to the amount of preliminary knowledge that can be reasonably assumed on the part of the student. It is a matter of common observation that a mathematical genius is rarely ever a good mathematical teacher, because he usually fails to appreciate the difficulties experienced by those who are less gifted than himself. Even when the teaching is to be not oral, but by use of the printed page, it is wonderfully easy to express mathematical truths in such form as to put them quite beyond the grasp of a fairly intelligent student.

It is not in the domain of acoustic science, but in the art of text-book adaptation that the present volume is found somewhat wanting. If the reader can be assumed to possess already a good knowledge of general physics he will find much to interest him. But if he is to obtain his introduction to acoustics through the medium of this text-book he will not proceed very far without becoming discouraged. Undervived formulas are employed so frequently that the reader who does not recognize them is justified in being impatient. He takes little satisfaction in reading that an unfamiliar mathematical statement 'can be proved;' or that it 'can be shown from the equation, etc.,' which in turn 'can be reduced to' another unrecognized form. Such statements are, of course, occasionally necessary, but in a text-book their use should be reduced to a minimum. In the great majority of cases such demonstrations amount to no demonstration at all. It is readily perceived that the author has gone through the requisite mathematical work, but does not wish to cumber his page with the details that are indispensable to a clear understanding of the subject by the student.

In a mathematical text-book, whether this term be applied to pure mathematics or to a book involving the applications of mathematics, it is of the utmost importance that all paragraphs shall be numbered, that equations shall also be numbered, and that the relation between new and old topics shall be indicated by frequent cross references. Attention to such details increases the labor of composition for the author, while the neglect of them greatly

magnifies the labor which hundreds of readers are compelled to undergo. They are wholly neglected in the present volume.

There are certain topics in acoustics which require the use of calculus for satisfactory treatment, but of which the practical results are so important that these cannot be omitted in an elementary treatise. Such, for example, is the equation expressing the relation between velocity of propagation, elasticity and density. For propagation of longitudinal waves the method of deduction without higher mathematics, first brought out by Rankine thirty years ago, is well known. In the present text-book an independent method is employed in which the formula is briefly deduced by discussion of the displacement curve for a longitudinal disturbance. Laplace's correction is satisfactorily explained, but in the application to numerical examples the student is required to apply thermodynamic principles, with which certainly the elementary student cannot be assumed to be familiar, but which will, doubtless, be explained in the future volume on 'Heat.'

The chapter on 'Frequency and Pitch of Notes' is particularly good. In the discussion of musical quality and of concord and discord prominence is justly assigned to the masterly researches of Helmholtz, but very little attention is given to the work of Rudolph König. In like manner the work of Mayer in America fails to receive any mention. The discussion of singing flames will be found better than in most text-books, including an excellent exposition of Lord Rayleigh's investigation on this subject.

On the whole the book is much to be commended to those who are already acquainted with the principles of acoustics and who wish a modern presentation of the subject by men of high standing. For a class text-book, as commonly employed in America, it will scarcely be found well adapted.

W. LE CONTE STEVENS.

WASHINGTON AND LEE UNIVERSITY.

Photographic Optics. By R. S. COLE, M.A. New York, D. Van Nostrand Co. 1899. Pp. 330.

The aim of this handbook, which was origi-

nally published in England by Samson Low, Marston & Co., is to give an elementary presentation of such of the problems of optics as find application in practical photography. A careful perusal of the book leaves in the reviewer's mind the impression that the emphasized word in the title should be 'optics' and not 'photographic;' that is, 'photographic' in the sense that most American amateur photographers would use the word. The book is written from the standpoint of the student of optics rather than that of the up-to-date practical photographer.

The photographer will find given in the various chapters of the book an excellent treatment of the various optical conditions encountered in using the camera, and this treatment is thorough and made as simple as the nature of the subject will admit; the author going back to first principles in all possible cases.

Perhaps the most important section is the one on lens testing, which contains an account of the tests employed at the Kew Observatory. Photographers are too apt to assign the same degree of excellence to all lenses of the same make; but the fact is that no manufacturer turns out two lenses just alike.

The photographic-lens industry is assuming such large proportions in this country that some one of our institutions ought to establish a lens-testing department which shall duplicate here the work of the Kew Observatory in England, so that when the practical photographer buys his lens he can receive with it a certificate of excellence.

We could wish that Mr. Cole had given us detailed information in regard to the construction and use of the various modern lens combinations, such as the Zeiss, Goerz and Steinheil lenses. These are points on which the ordinary amateur photographer is utterly ignorant, and even a modest amount of enlightenment would be of great benefit to him.

The author certainly dismisses too abruptly the subject of calculating the brightness of the image and timing exposures. It is not such a wholly empirical matter as is represented. Our best amateur photographers do calculate as accurately as possible the time of their exposures, and their results warrant this expendi-

ture of care and time. Still another point that should have been treated in greater detail is the use of the ortho-chromatic plate.

On such points as the last two mentioned there is a lack of practical information which will give the book less of a circulation than it should have and deserves to have on account of its many excellent qualities.

FRANK WALDO.

BOOKS RECEIVED.

Man, Past and Present. A. H. KEANE. Cambridge University Press. 1899. Pp. xii + 584.

A Short History of Free Thought; Ancient and Modern. JOHN M. ROBERTSON. London, Swan, Sonnenschein & Co., Ltd.; New York, The Macmillan Company. 1899. Pp. xii + 446.

Vital Statistics. ARTHUR NEWSHOLME. London, Swan, Sonnenschein & Co.; New York, The Macmillan Company. 1899. Pp. xii + 353.

Handbook of British, Continental and Canadian Universities, with special mention of the Courses open to Women. ISABEL MADDISON. New York, The Macmillan Company. 1899. Pp. iv + 174.

SOCIETIES AND ACADEMIES.

THE SCIENCE CLUB OF THE UNIVERSITY OF WISCONSIN.

At the meeting of the Club held on May 12th papers were read by G. C. Comstock on 'Some Recent Applications of Photography to Astronomical Discovery' and by F. H. King on 'The Flow of Liquids through Porous Media.'

Officers for the ensuing year 1899-1900 were elected as follows: President, Mr. Charles R. Van Hise; Vice-President, Mr. Edward Kremers; Secretary and Treasurer, Mr. Charles F. Burgess.

On the evening of May 6th the Club gave a



MEDAL OF THE SCIENCE CLUB OF THE UNIVERSITY OF WISCONSIN.

Every-day Butterflies: A Group of Biographies. SAMUEL HUBBARD SOUDDER. Boston and New York, Houghton, Mifflin & Company. 1899. Pp. 386.

A Selected Biography of the Anthropology and Ethnology. WILLIAM Z. RIPLEY. Boston, Trustees of the Boston Public Library. 1899. Pp. 159.

Thatsachen und Auslegungen in Bezug auf Regeneration. AUGUST WEISMANN. Jena, Gustav Fischer. 1899. Pp. 31.

Traité élémentaire du mécanisme chimique fondée sur le thermodynamique. P. DUHEM. Paris, Hermann. 1899. Pp. 381.

dinner in the Madison Guild Hall in recognition of the election of its first President, Mr. George Cary Comstock, to the National Academy of Sciences, and the awarding of a medal to its second President, Mr. Stephen Moulton Babcock, by the Legislature of the State of Wisconsin.

On June 22d the first award of the Science Club Medal will be made to that member of the senior class of the University of Wisconsin who presents the best thesis giving the results of his own original investigation of a scientific

subject. Dies have been prepared by Thomas Moring, of London, from which a medal in bronze will be struck annually for this purpose.

WM. H. HOBBS.

TORREY BOTANICAL CLUB, MARCH 29, 1899.

THE first paper was by Francis E. Lloyd, on 'The Functions of the Suspensor,' and was illustrated by drawings and a series of microscopes exhibiting slides.

Mr. Lloyd described the structure of the suspensor typical of the genera *Galium*, *Asperula*, *Vaillantia*, etc., and showed that haustoria are formed which absorb food from the endosperm. The large basal cell of *Capsella* was shown also to possess a function quite similar, because, as the preparations showed, the basal cell destroys the tissue of the inner integument in its vicinity and thus becomes imbedded in it.

The second paper was by Mrs. E. G. Britton, on 'The Ferns of the Eastern United States,' illustrated by the stereopticon.

Mrs. Britton exhibited mounted specimens of all the rarer ferns of the Eastern States, many of them of her own collection, giving the range of each species. She also exhibited lantern slides made from photographs of these ferns taken as they grow. Those of the maiden-hair, hart's tongue and beech-fern were taken from the fernery in the New York Botanical Garden; five of them were views from the Catskill Mountains taken by Mr. Van Brunt; Mr. Hulst contributed one from Lake George, and Mr. Lorenz five from Willoughby Lake, Vt. Others were Adirondack views taken by Stoddard. Mrs. Britton stated that she would continue to fill in the omissions where she had not been able to obtain photographs, and hoped to complete her collection in the future. She expressed the hope that as the interest in ferns increases, the love of them would likewise grow, and that the rarer ones would not be exterminated by useless transplanting to locations where they will not survive. It was stated that thus far Rutland county, Vermont, shows the greatest number of ferns of any county in the Eastern States, having 42 species and 10 varieties. There are seldom more than 20 species in any locality, except where there is a great variety of soil and habitat, as at Jamesville, N. Y.,

where Professor Underwood has found 34 species. Long Island has 25 and Staten Island 23 species.

In further illustration, the Torrey Club collection of ferns and many sheets from the Columbia collection were exhibited, also a series of photographs from Professor Atkinson, showing the variations produced by cultivation of *Onoclea sensibilis*.

An exhibit to illustrate *Onoclea sensibilis* in the fossil state was also furnished by Dr. Hollick, being of special interest as the only living species which is actually found fossil.

Mr. William A. Lawrence, of Hartford, Conn., was introduced by Dr. Rusby, as one who had collected 34 species of ferns about Willoughby Lake, Vt. Mr. Lorenz described the lake and neighboring cliffs, with the illustration of lantern slides, and spoke of the hundreds of plants of *Woodsia glabella* flourishing there close together, fruiting at one inch or at six inches. In the sunshine it becomes more leathery, as if passing into *W. hyperborea*. Mr. Lorenz also finds *Aspidium spinulosum dilatatum* reverting there to the type of the species.

Dr. Rusby and Dr. A. R. Grout also described their visits to Willoughby Lake.

Mr. W. A. Clute exhibited several fronds of *Dryopteris simulata*, collected by him at Babylon, L. I., last summer, and pointed out a distinction from *D. Thelypteris* in the fact that each pinna of *D. simulata* is not of uniform breadth but broader near the middle. It fruits chiefly in the shade, *D. Thelypteris* in the sun.

Dr. Rusby spoke of the beauty of the ferns on the mountain slopes near Plainfield, N. J., and of the localities near there for *Asplenium ebenoides*, *Cystopteris fragilis* and *Cheilanthes lanuginosa*.

Mr. Clute remarked that he had collected 16 species of ferns within a mile of Fort Lee, and 59 species are now growing at the Botanic Garden.

EDWARD S. BURGESS,

Secretary.

ZOOLOGICAL CLUB, UNIVERSITY OF CHICAGO—
MEETINGS OF WINTER AND SPRING
QUARTERS, 1899.

Ovarian Structure in an Abnormal Pigeon.—
The bird in question was the offspring of a

Vienna white (*Columba alba*) and a common ring dove (*Turtur risorius*). She was remarkable for her unusual appearance and manner, and upon dissection the ovary was found to be abnormal. The first thing in the structure of the ovary to strike the attention was the large number of double eggs, that is, two or more eggs lay within the common follicle; they might or might not be separated by a distinct membrane.

Most of the larger eggs were vacuolated, the vacuoles always appearing in connection with the substance of the sphere or yolk-nucleus. This sphere substance seemed to be also closely related to the membrane separating double eggs.

The nuclei in many cases were shrunken and seemed to be degenerating. Nucleoli were frequently present, but in many cases were indistinct and irregular in outline. Mitotic division of the nucleus was never observed, although one or two centrosomes were often present. Many of the eggs, especially the larger ones, were undergoing resorption by means of phagocytes which were the transformed follicle cells. Instances were found where the follicle cells had disappeared along part of the periphery of the egg, leaving behind a deposit of pigment. The doubling of the eggs seemed to be due in most of the smaller ones to division of the primordial egg cell, and in the larger ones to fusion of contiguous cells. The cause of such abnormalities is not known. Some connection with hybridization may be shown later.

MICHAEL F. GUYER.

Titles of papers given during the two Quarters: 'Life-History of *Dicyema*,' Professor W. M. Wheeler; 'Abnormalities in Ovipogenesis,' M. F. Guyer; 'Recent Literature on Annelid Morphology,' R. S. Lillie; 'Experimental Production of Meroblastic Cleavage in the Frog's Egg (O. Hertwig), Dr. C. M. Child; 'Recent Experimental Work on the Ctenophore Egg' (Fischel & H. E. Zeigler), Dr. C. M. Child; 'Some Native Americans' (illustrated), A. L. Melander & C. T. Brues; 'The Formation of Giant Embryos in *Ascaris*' (Zur Strassen), H. H. Newman; 'Blind Fishes,' Professor C. H. Eigenmann, of the University of Indiana; 'In-

stincts and Habits of Solitary Wasps (Peckham), Miss M. M. Enteman; 'The Evolution of the Color-pattern in the Pigeon's Wing,' Professor C. O. Whitman; 'The Excretory Organs of Petromyzon,' Professor W. M. Wheeler; 'The Excretory System of Turtles,' Miss E. R. Gregory; 'A Review of the Phosphorescent Organs of Animals' (illustrated), Professor S. Watasé; 'Hybridism in Pigeons,' M. F. Guyer.

DISCUSSION AND CORRESPONDENCE.

TOTEMISM.

TO THE EDITOR OF SCIENCE: Totemism has been a most obscure subject, and it is only of late that any real light has been thrown on it by the publication of Baldwin-Gillen's 'Native Tribes of Central Australia,' which is ably discussed by Mr. J. G. Frazer in the April and May numbers of the *Fortnightly Review*. Among the Australians an Emu group, *e. g.*, is that who by refraining from killing and eating emus show that by their friendship with emus they acquire power with them, and identify themselves with the emus by blood ceremonies and by masquerading as emus. Now, all this we may interpret as a trap, a bit of animistic cunning like that of the hunter stalking. The Emu men are specialized as a group to a control over the emus by magic rites, making them multiply and be convenient food for the rest of the tribe. Totemism is a cooperation primarily for food supply; "you Grub men get grubs for me by your special kinship with grubs, and we Emu men likewise will get emus for you." The Totemic method is a sly specialization by which a tribe of men get the best of their animistic fellows—emus, grubs, rain, etc.—for their own advantage, and so the Totemic organization is not a religious, but wholly an economic, socialization.

It appears to us that this interpretation, as we have just expressed it, is sufficient, and Mr. Frazer's remark about the motive of 'inconsistency' which restrains from eating Totem, as a cannibalism, presumes too much on the logical power of the native. And cannibalism is a common thing in nature; but among men and most animals is reduced to eating one's enemies or persons of another tribe; hence when the

Totem is adopted into near kinship we merely see, in the not-killing and eating, that which follows naturally the rule of human kinship. But if the main motive in abstaining from eating Totem 'is to conciliate,' then Totemism is so far religious as a method of dealing with superiors, for in a broad sense religion includes all acts toward the superior as such. But Totemism, so far as it makes the native coercive to his fellow animals by force of cunning magic, certainly is unreligious.

As to Exogamy, while this may arise similarly with abstinence from killing and eating, and is thus a saving from supposed incest, as Mr. Frazer says, we would also see that marriage within a Totem group might have the undesirable result of a Totem animal as offspring instead of a human child. Mr. Frazer reports something analogous in his book on Totemism (page 16): "Bakalai think that if a man were to eat his Totem the women of his clan would miscarry and give birth to animals of the Totem kind or die with an awful disease."

It would be of interest to know whether there is a Totemic instinct and whether it emerges in civilized children. I think it might be found, especially among street Arabs and others early thrown on their own resources. As to Totemism bearing on the domestication of animals, the researches of McGee and others in the United States favor domestication of animals from commensalism. (Cf. also domestication of snakes as rattlers in the Philippines.) Totemism certainly acts analogously to a limited close period by restricting those who shall kill and eat certain food animals; but the Totemic idea of controlling by spell is contrary to the idea of direct subjection, and would scarcely lead to it. The Totem group are merely those who stay at home, and by their intimate relationship weave the spells by which the prey is made plenteous and convenient to the hunter.

In Totemism and also Fetichism—which is but a means to Totemic power—we see the first groping of the human mind toward causal relation and its practical application; but so grossly animistic, especially in its kinship idea, as to be difficult of understanding by civilized man with his scientific mode of thought. The

Totemic control of nature by making oneself akin, is antipodal to the depersonalizing scientific method. Totemism is the human animal fascinating his prey by kinship rite and spell.

HIRAM M. STANLEY.

LAKE FOREST, ILL., May 29, 1899.

AROUSAL OF AN INSTINCT BY TASTE ONLY.

EDITOR OF SCIENCE: The following observation is submitted on the chance that it may be of use. A dead mouse was given to two kittens eight weeks old. They showed no interest in it from sight or smell, but as soon as they were made to taste the mouse they went into a fighting passion, which remained as long as the mouse was tasted. When they were forced to give up the mouse, all interest was lost and could not be aroused even by smell. Yet as soon as the tongue again touched the mouse the kitten fell into the same passion of fighting. One test showed marked results. Giving the mouse to one kitten, I held it, scratching vigorously, in one hand, while with the other hand I made the other kitten touch and smell the mouse and finally taste it. As long as the second one did not taste the mouse it showed no interest, but it began to fight vigorously at the moment of tasting. As soon as the first kitten was made to release its hold on the mouse it at once ceased to show any interest.

E. W. SCRIPTURE.

CURRENT NOTES ON METEOROLOGY.

INFLUENCE OF THE GREAT LAKES ON PRECIPITATION.

THE *Meteorological Chart of the Great Lakes for June* (U. S. Weather Bureau) presents a chart of the normal annual precipitation of rain and snow in the drainage basins of the Great Lakes, with a set of tables and a brief summary prepared by A. J. Henry. The conclusion reached as to the influence of the Lakes on precipitation is as follows: With the possible exception of Lake Superior, the lakes do not seem to have a very marked influence on the precipitation over adjacent land areas. There is more precipitation on the south than on the north side of Lakes Superior, Erie and Ontario, the differ-

ence in the case of Lake Superior being about eight inches, while the average precipitation on the south shores of Lakes Erie and Ontario is about three inches greater than that on the north shores. The eastern shores of Lakes Michigan and Huron have a greater precipitation than the western, but the differences are not so strongly marked as between the northern and southern shores of the other lakes. The annual precipitation is somewhat less over the northern peninsula of Michigan as compared with the immediate shore line, and the precipitation over the interior of the northern portion of the lower peninsula is considerably less than on the shores of the lakes on either side.

REPORT OF THE CHIEF OF THE WEATHER BUREAU.

The Report of the Chief of the Weather Bureau for 1897-98 is an unusually interesting volume. We note that Section I., which deals with *New Work and Special Investigations*, includes an account of the kite work, illustrated by reproductions of a considerable number of kite meteorograph curves. Deaths by lightning during the year 1897 are reported as reaching 362, which is the largest number in any single year since a record has been kept. The number of deaths due to violent storms was 55. Part VII. contains *The Climate of Cuba*, by W. F. R. Phillips, a somewhat fuller account than that published in Bulletin No. 22 (see SCIENCE, July 1, 1898, p. 16); *Temperature, Rainfall and Humidity at San Juan, Porto Rico*, and *The Weather of Manila*, both by W. F. R. Phillips. The latter account was contained in Bulletin No. 22. Two papers by Professor H. A. Hazen, one on *Meteorologic Waves* and one on *The Distribution of Moisture in the United States*, both well illustrated, close the volume.

JAMAICA WEATHER SERVICE.

OWING to the withdrawal, by the government, of the annual subsidy, the Jamaica Weather Service came to an end on April 1st of this year. This service was established in 1880, and has done valuable work in furnishing warnings of coming hurricanes, as well as in carrying on and publishing investigations of hurricanes, rainfall, damage by lightning, etc.

Mr. Maxwell Hall has been in charge of the Jamaica Weather Service from the start, and has had the able assistance of Mr. Robert Johnstone, as observer in charge at Kingston. The announcement is now made that Mr. Johnstone's services must be dispensed with, and that the first-class station at Kingston and the second-class station at Montego Bay must be discontinued.

NEW DAILY WEATHER MAPS.

The Monthly Weather Review for March notes the issue of two new daily weather maps, one in Canada and the other in Mexico. In the summer of 1898 the Canadian Meteorological Service established a Pacific Coast Division with headquarters at Victoria, B. C. An interchange of daily telegraphic reports takes place between our own Weather Bureau and that of Canada, so that the information available to one is also accessible to the other. It is expected that daily maps and forecasts will be issued by the Pacific Coast Division of the Canadian Weather Service similar to those now issued by the U. S. Weather Bureau at San Francisco and at Portland, Ore. On March 1, 1899, the Republic of Mexico began the publication of a daily weather map, 12 by 16 inches in size, the observations being made at 8 a. m., 75th meridian time. The map makes possible an immediate connection with the daily maps of the United States and of Canada.

WINTER TEMPERATURES AT DAWSON CITY.

The Monthly Weather Review for March also contains a summary of some meteorological observations made at Dawson City during November and December, 1898, and January, 1899, by U. G. Myers, Observer, Weather Bureau. The maximum in November was 23.3°; the minimum, -41.4°. In December the maximum was 38.0° and the minimum -41.0°. In January the maximum and minimum were 2.0° and -45.0°, respectively.

RECENT PUBLICATIONS.

The Use of Kites in the Exploration of the Upper Air. C. F. MARVIN, Professor of Meteorology, U. S. Weather Bureau. Year-book of

the Department of Agriculture for 1898. Pp. 201-212. Pls. I. Figs. 9.

Description of the standard Weather Bureau kite and apparatus, with illustrations.

Proceedings of the Convention of Weather Bureau Officials held at Omaha, Nebraska, October 13-14, 1898. Prepared under the direction of WILLIS L. MOORE, Chief of Weather Bureau. U. S. Department of Agriculture, Weather Bureau. Bulletin No. 24. 8vo. Washington, D. C., 1899. Pp. 184.

This Bulletin contains a large number of papers on a wide range of subjects connected with the work of the Weather Bureau and with the relations of the Bureau to the public.

R. DEC. WARD.

HARVARD UNIVERSITY.

BOTANICAL NOTES.

THE VARIETIES OF CORN.

SEVERAL years ago the lamented Dr. Sturtevant published privately the results of his studies of Indian Corn, with especial reference to the varieties which have been created by man since he has had it under cultivation. The value of the original paper was such that the Department of Agriculture has done wisely in determining to bring out this considerably enlarged and improved edition as one of the publications of the Office of Experiment Stations (Bulletin No. 57). It is an attempt to treat in a scientific manner the whole problem of the varieties into which the originally single species has developed under man's selection. It is thus a contribution to our knowledge of the evolution of a species under cultivation.

The paper opens with a technical description of the Family *Gramineae*, the tribe *Maydeae* and the genus *Zea*, and then follow descriptions of 'the one recognized species,' *Zea mays* L., and the 'species groups.' In discussing the variations in the species the author says: "The species *Zea mays* includes exceedingly divergent forms. The height of the plant in varieties and localities has been reported from 18 inches for the Golden Tom Thumb pop to 30 feet or more for varieties in the West Indies, and single stalks in Tennessee at 22½ feet. I have

seen ears 1 inch long in the pop class and 16 inches long in the dent class. The rows in varieties may vary from 8 to 24 or more, and in individual ears are reported from 4 to 48. A hundred kernels of Miniature pop weighed 46 grains, of Cuzco soft 1,531 grains. In some varieties the ears are long and slender; in others, short and thick; in the Bear Foot pop, flat. Some varieties have flat kernels; other varieties have spheroidal kernels; yet others, conical kernels. The summits of the kernels may be flat, rounded, pointed or indented. These kernels, usually upright on the cob, may be sloping or imbricated, firm or loose, usually sessile, yet sometimes stalked. In structure some are corneous throughout; others are partly corneous and partly farinaceous, others entirely farinaceous. * * * The season also varies. A variety that ripens in one month is mentioned from Paraguay, and seven months are said to be required in some southern countries. * * * In one group of corn each kernel is surrounded by a husk and the ear thus formed is itself enveloped in husks. In all our field and garden corns, however, the seed is naked on the cob."

With all these variations before him the author finds little difficulty in dividing the 'polymorphic species *Zea mays*' into a number of groups, "which, on account of their well-defined and persistent characters, may be considered as presenting specific nomenclature." Accordingly, the author proposes six 'species groups,' each having the value of species in process of formation (if we understand the author aright). These species of a lower order are as follows:

1. *Zea tunicata*, the pod corns, in which each kernel is enclosed in a pod or husks. This is thought by some to be the type of the primitive maize, but Dr. Sturtevant very shrewdly suggests that "a more complete study, with more ample material, may possibly bring this group under the classification of abnormalities, the pod being but a proliferous condition."

2. *Zea everta*, the pop corns, in which the excessive proportion of corneous endosperm and the small size of the kernels and ears are characteristic. Twenty-five varieties are recognized.

3. *Zea indurata*, the flint corns, in which the corneous endosperm encloses a mass of starchy endosperm, the summit of the kernel being in all cases covered by the corneous layer. Sixty-nine varieties are recognized, among which the common 'Eight-rowed corn of New England' is a familiar example.

4. *Zea indentata*, the dent corns, in which the corneous endosperm occurs at the sides only of the kernel, the starchy endosperm extending to the summit. By the drying and shrinkage of the starchy matter the summit of the kernel becomes indented, whence the name 'dent' corn. No less than 323 varieties are recognized as belonging to this 'species group,' of which the common corn of the Central States, North and South, furnishes many examples.

5. *Zea amylacea*, the soft corns, characterized by the absence of corneous endosperm. Twenty-seven varieties are recognized. Tuscarora, Cuzco and Zuni are examples. "The mummy corns, from Peru and Chili, that I have examined have been soft corns in four varieties."

6. *Zea Zaccarata*, the sweet corns, characterized by the translucent, horny appearance of the kernels, and their more or less crinkled, wrinkled or shriveled condition. Sixty-three varieties are recognized.

While we may not be willing to accept these 'species groups' as species in the ordinary sense, it is fair to say that, in our opinion, they are as much entitled to specific rank as many of those which have been described recently. If the systematic botanists ever turn to such plants as Maize, Wheat, etc., we may expect not only the acceptance of the forms indicated above as good species, but also the addition of many more.

THE AGRICULTURAL GRASSES OF KANSAS.

A RECENT Experiment Station Bulletin (No. 87) issued by the Kansas Station contains some matter of more than usual interest to botanists. It deals with the grasses of importance to agriculture, and on that account might be supposed to contain little, if anything, of value to the scientific botanist, but it requires only an examination of this bulletin to show that one cannot judge of the value of a paper by the title.

Professor Hitchcock has made a paper of much interest to the botanist, and we dare say that it is not one whit less useful to the farmers for whom, primarily, it was written. Twenty-six species of wild grasses are mentioned, and, by means of illustrations and popular descriptions, their identity will not be difficult for the farmer and stockman. To the botanist the neat little maps which show the distribution of the species are full of interest, as are also the paragraphs which indicate, popularly, it is true, the main phytogeographic features of the State. The latter are as follows: Wooded regions; sloughs, swales and wet meadows; bottom lands; prairies of eastern Kansas; sandy regions; stony hills; salt plains and alkali spots. One cannot but regret that the text is disfigured by the spelling 'thru' and 'thruout,' but we surmise that this is not to be laid at the door of the writer of the Bulletin.

DISEASES OF THE SWEET POTATO.

THAT delicious vegetable, the sweet potato, is affected most grievously by diseases which must make life a burden to the grower, whatever they may do to the unfortunate plants themselves. In a recent bulletin issued by the Maryland Experiment Station, Dr. C. O. Townsend described eight diseases of the sweet potato. These are known under the following names: Black Rot, Soil Rot, Soft Rot, Stem Rot, White Rot, Dry Rot, Scurf, Leaf Mould. In every case the disease is produced by a fungous parasite which attacks the tissues. Thus Black Rot is caused by *Ceratocystis fimbriata*; Soil Rot by *Acrocystis batatas*; Soft Rot by the ubiquitous 'black mould' *Rhizopus nigricans*; Stem Rot by *Nectria ipomææ*; White Rot by some *Penicillium*; Dry Rot by *Phoma batatæ*; Scurf by *Monilochaetes infuscans*; Leaf Mould by *Albugo (Cystopus) ipomææ-panduranæ*. Nine years ago Dr. Halsted, of the New Jersey Experiment Station, published a similar paper (Bulletin 76) in which he described still another disease of this sorely afflicted plant, viz., Leaf Blight caused by *Phyllosticta bataticola*, making nine diseases in all. The remedies to be employed by the growers include the following: Discard all diseased sets; spray with Bordeaux mixture; rotate crops; treat the soil with sul-

phur, four hundred pounds to the acre; gather and burn all diseased roots at the time the crop is harvested; destroy all related weeds, avoid bruising the tubers; store in dry places at a temperature of about 70°; remove and burn diseased tubers as soon as they begin to decay. Surely the grower of the sweet potato must be alert to bring his crop to a successful issue.

CHARLES E. BESSEY.

UNIVERSITY OF NEBRASKA.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE preliminary announcement of the forty-eighth meeting of the American Association for the Advancement of Science has been issued by the local committee. It will be remembered that the meeting will be held at Columbus, Ohio, from the 21st to the 26th of August, under the presidency of Professor Edward Orton. The first general session will as usual be held on Monday morning, when the President elect will be introduced by the retiring President, Professor F. W. Putnam, and addresses of welcome will be made by the Governor of Ohio and the Mayor of Columbus. The addresses of the Vice-Presidents will be given on Monday afternoon, and the address of the retiring President in the evening. The several sections will meet as usual during the week, and Saturday will be devoted to an excursion, probably to the mounds at Fort Ancient, the coal mines in Hocking Valley and the natural-gas fields. Further information may be obtained from the Permanent Secretary of the Association, Dr. L. O. Howard, Cosmos Club, Washington, D. C., and from the Local Secretary, Professor B. F. Thomas, Ohio State University.

The societies meeting in affiliation with the Association are as follows:

The American Forestry Association will meet on Tuesday and Wednesday, August 22d and 23d, in Horticultural Hall. Hon. James Wilson, Washington, D. C., President; G. P. Whittlesey, Washington, D. C., Secretary.

The Geological Society of America will meet on Tuesday, August 22d, at the same time and place with Section E. B. K. Emerson, Amherst, Mass., President; H. L. Fairchild, Rochester, N. Y., Secretary.

The American Chemical Society will hold a general meeting on Monday and Tuesday, August 21st and 22d, and the remainder of the week will be given to Section C. Edward W. Morley, Cleveland, Ohio, President; Albert C. Hale, 551 Putnam Avenue, Brooklyn, N. Y., Secretary.

The Society for the Promotion of Agricultural Science will meet on Friday and Saturday, August 18th and 19th. B. D. Halsted, New Brunswick, N. J., President; C. S. Plumb, Lafayette, Ind., Secretary.

The Association of Economic Entomologists will hold its eleventh annual meeting on August 18th and 19th. C. L. Marlatt, Washington, D. C., President; A. H. Kirkland, Malden, Mass., Secretary.

The American Mathematical Society will meet on Friday and Saturday, August 25th and 26th. R. S. Woodward, Columbia University, New York, President; F. N. Cole, Columbia University, New York, Secretary.

The Society for the Promotion of Engineering Education will hold its meeting on August 17th, 18th and 19th. Albert Kingsbury, Durham, N. H., Secretary.

The American Folk-Lore Society will probably meet with Section H on Thursday, August 24th. W. W. Newell, Cambridge, Mass., Secretary.

The Botanical Society of America will meet on Friday and Saturday, August 18th and 19th. On Friday, at 4 p. m., business meeting; 8 p. m., address of retiring President; on Saturday, 9 a. m., business meeting; 9:30 a. m., and 2 p. m., sessions for reading papers. G. F. Atkinson, Ithaca, N. Y., Secretary.

The American Microscopical Society will meet August 16th, 17th and 18th. Henry B. Ward, Lincoln, Neb., Secretary.

THE CENTENARY OF THE ROYAL INSTITUTION.

THE celebration of the centenary of the foundation of the Royal Institution, London, took place in accordance with the plans we have already announced. Commemorative addresses were made by Lord Rayleigh and Professor Dewar, and at the banquet on June 5th

the Prince of Wales, the Duke of Cambridge and Professor Langley, of the Smithsonian Institution, made speeches.

As part of the celebration there was an exhibition of historical apparatus, regarding which we take the following from the *London Times*: Most of it belongs to the Institution's own collection, but a considerable number of articles are on loan, some memorials of Davy having been sent by Dr. Humphry Davy Rolleston, his grand-nephew, and some of Faraday by his niece, Miss Jane Barnard, and other members of the Barnard family. The founder, Count Rumford, is represented by some models—a grate, fireplace, chimneys, roaster and stew-pan, which may be taken as typical of the purposes which he conceived the Institution should serve. Of the first professor, Dr. Garnett, nothing seems to remain but his picture, and the objects that belonged to the second, Dr. Thomas Young, are not very numerous or striking.

Of Sir Humphry Davy, however, the relics are most interesting, for they carry the mind back to what are probably his two best-known achievements. In the first place there is a couple of the batteries or galvanic troughs with which he was able to effect the decomposition of the alkalis, and in the second a large collection of the lamps with which he experimented in the effort—finally, of course, successful—to find a form safe for use in dangerous coal mines. Other memorials of Davy include a portrait of him in court dress occupying the presidential chair of the Royal Society, the three medals he received at various times from that body, the Napoleon medal for the 'best experiment on the galvanic fluid' awarded him in 1807 by the French Institute, whose action raised a storm of indignation, because England and France were then at war, and many specimens of his correspondence, not the least interesting being some of the love letters he addressed to the charming Mrs. Apreece, his marriage with whom in 1812 terminated his connection with the Institution.

The articles associated with Faraday are still more numerous. There is the original apparatus with which he obtained the magneto-electric spark; the big electro-magnet with a copper

disc spinning between its poles, which formed the first machine for continuously generating an electric current by means of magnetism, and which is, therefore, the direct ancestor of the modern dynamo; early forms of galvanometers and electrical-influence machines; a series of delicate glass vessels filled with various gases, which he used in his determinations of magnetic and diamagnetic properties, together with the 'diamagnetic box' he presented to Tyndall; the apparatus employed in the first experiments on the liquefaction of gases, with some of the tubes filled by himself; many specimens of the heavy glass in which he did such memorable work; and a curious bit of apparatus, consisting apparently of a block of this glass, surrounded with a coil of fine wire, which he doubtless used in one of his numerous experiments to discover a connection between light and magnetism. The way in which the last is put together shows plainly the influence of the apprenticeship to a bookbinder which Faraday served in his early life, and another beautifully neat example of his expertness in this craft may be seen in a bound manuscript volume of Davy's lectures 'taken off from notes by M. Faraday,' which is particularly interesting as having led to his engagement as an assistant in the institution's laboratory.

Among the apparatus belonging to men more recently connected with the Royal Institution may be mentioned that used by Tyndall in his investigations on radiant heat and on germ life, the electrical instruments of Dr. Warren de la Rue, and last, but not least, the magnificent collection of physical apparatus that was the property of the late Mr. William Spottiswoode, successively Treasurer and Secretary of the Institution. This includes a splendid series of Nicol's prisms and other apparatus for experimenting in the polarization of light, a huge electro-magnet made by Ducretet, of Paris, and the famous induction coil containing 280 miles of wire in its secondary circuit and capable of giving a spark $3\frac{1}{2}$ feet long. The whole has just been presented to the Institution by Mr. W. Hugh Spottiswoode, and it will form a most worthy memorial of the year in which that society completes its century of useful and honorable existence.

SCIENTIFIC NOTES AND NEWS.

SECRETARY LONG, of the Navy Department, has appointed a Board of Visitors to examine and report upon the U. S. Naval Observatory, to consist of Senator Wm. E. Chandler; Representative Alston G. Dayton; Professor Geo. C. Comstock, Director of the Observatory of the University of Wisconsin, Madison, Wis.; Professor Geo. E. Hale, Director of the Yerkes Observatory, Williams Bay, Wis.; and Professor Edward C. Pickering, Director of the Harvard College Observatory, Cambridge, Mass. This Board of Visitors will meet at the Naval Observatory on the 30th of the month.

WE learn from Dr. Tiessen, of Berlin, that the Norwegian Storting has passed an act regulating the administration of the Nobel foundation. The prizes, which it will be remembered are in physics, chemistry, medicine, literature and for the promotion of peace, will each be of the value of 15,000 crowns (about \$11,000) annually. The prizes are to be conferred on the anniversary of Nobel's death, on the 18th of December, and for the first time in 1901. The prizes in physics and chemistry are to be awarded by the Swedish Academy of Sciences and the prize in medicine or physiology by the Medico-Surgical Institute of Stockholm. Any one making application for one of the prizes is thereby excluded. A prize may be divided between two persons who have carried out a joint work. It appears that part of the income is to be used for the establishment of Nobel Institutes, regarding the scope of which we are not informed.

SEVERAL years ago Dr. Robert Lamborn bequeathed to the Philadelphia Academy of Natural Sciences his entire estate, valued at over \$600,000. The will was contested and a compromise has now been effected by which half of the property is received by the Academy.

THE American Geographical Society, New York, has bought a plot of land 50 x 102 feet on the north side of West 82d St., near Central Park, and facing the open square on which stands the American Museum of Natural History. In addition to the legacy of General Cullum, subscriptions amounting to \$30,400 have been received, and the Council proposes to

begin the construction of a fire-proof building, completing it at present only so far as may be necessary to provide for a library and offices.

ON the occasion of the official inspection of the Royal Observatory, Greenwich, on June 3d, the new buildings were opened to visitors. The new Observatory building, which has been in progress since 1891, was completed last March by the addition of the east and west wings, and a new magnetic pavilion, in an enclosure in Greenwich Park, about 360 yards from the Observatory, was completed last September. Among the distinguished visitors present were M. Cornu and Professor Newcomb.

THE University of Oxford, on June 8th, entertained the delegates to the centenary of the Royal Institution and conferred the honorary D.C.L. upon the following: Henri Becquerel, Membre de l'Institut, professor of physics at the École Polytechnique, Paris; Guglielmo Körner, professor of chemistry in the Scuola Superiore d'Agricoltura, Milan; Matthias Eugen Oscar Liebreich, Director of the Pharmacological Laboratory, and professor of pharmacology in the University of Berlin; Henri Moissan, professor of toxicology in the École Supérieure de Pharmacie, Paris, and Simon Newcomb, U. S. Navy and Johns Hopkins University. At the luncheon, given in the hall of Christ Church, Professor Newcomb responded to the toast in honor of the guests.

THE following have been elected foreign members of the Royal Society: Dr. Ludwig Boltzmann, professor of theoretical physics in the University of Vienna; Dr. Neumayer, of the Hamburg Observatory; Dr. Anton Dohrn, Director of the Zoological Station, Naples; Professor Emil Fischer, professor of chemistry at the University of Berlin, and Dr. Melchior Treub, Director of the Buitenzorg Botanical Gardens.

ERNST A. BESSEY, A.M., of the University of Nebraska, has been appointed to the position of Assistant Vegetable Pathologist in the Division of Vegetable Physiology and Pathology in the United States Department of Agriculture, the appointment dating from June 1st.

THE subjects of Professor Emile Picard's lectures to be delivered at Clark University, in

connection with the Decennial Celebration, July 5th to 8th, are as follows: (1) Sur le développement des mathématiques, et en particulier de l'idée de fonction, depuis un siècle. (2) Quelques vues générales sur la théorie des équations différentielles. (3) Sur la théorie générale des fonctions analytiques et sur quelques fonctions spéciales.

THE statue of Benjamin Franklin, presented to the city of Philadelphia by Mr. Justus C. Strawbridge, was unveiled on June 14th with ceremonies under the auspices of the University of Pennsylvania, the American Philosophical Society, the Franklin Institute, the Library Company of Philadelphia, and the Pennsylvania Hospital. The oration was delivered by U. S. District Attorney James M. Beck.

THE death is announced of Dr. A. Charpentier, professor in the faculty of medicine in the University of Paris, and the author of contributions on vision numbering over 100. His publications concern especially the time phenomena of vision, intensity, contrast, etc.

DR. LAWSON TAIT, a surgeon of Birmingham, England, who was eminent for his operations in abdominal surgery, died in London on June 13th, aged fifty-five years.

THE next meeting of the International Committee on Meteorology has been called for August 25th of the present year at St. Petersburg.

THE annual meeting of the Royal Geographical Society, London, was held on June 5th, when the medals were awarded in accordance with the announcement that we have already made. A banquet was held in the evening. Among the speakers were Count du Pontavice de Heusey, who had received one of the medals in the afternoon, and the American Ambassador, Mr. Choate.

THE 21st Congress of French Geographical Societies will be held at the building of the Paris Society of Geography, from the 23d to the 29th of July, 1900.

DR. CYRUS ADLER informs us that Comte Angelo De Gubernatis, President of the 12th International Congress of Orientalists, to meet at Rome, October 12, 1899, states that a special

section of this Congress will be devoted to researches concerning the origin of the American Indians, and that papers from students of American archæology, ethnography, mythology and folklore will be welcome.

A REUTER telegram from Stockholm, dated June 6th, says that the Anthropological and Geographical Society of Stockholm has received the following telegram from Herr Vathne, a shipowner at Mandal: "Captain Hueland, of the steamship *I'aagen*, who arrived there on Monday morning, reports that when at Kola Fjord, Iceland, in 65° 34' north lat., 21° 28' west long., on May 14th, he found a drifting buoy marked 'No. 7.' Inside the buoy was a capsule, marked 'Andrée's Polar Expedition,' containing a slip of paper, on which was written the following: 'Drifting buoy, No. 7. This buoy was thrown out from Andrée's balloon on July 11, 1897, 10:55 p. m., Greenwich mean time, 82° north lat., 25° east long. We are at an altitude of 600 metres; all well. Andrée, Strindberg, Fraenckel.' " Herr Andrée made his ascent from Danes Island on July 11, 1897, at 3 o'clock in the afternoon, so that when the buoy was thrown out the explorer had only travelled seven hours and 55 minutes.

THE *Stella Polare*, with the Duke of Abruzzi, nephew of the King of Italy, and his polar expedition on board, sailed from Christiania on June 12th.

AMONG those who will embark on the steamship *Hope* for the Arctic regions are Professor Wm. Libbey, of Princeton University, and Dr. Robert Stein, of the U. S. Coast and Geodetic Survey. Dr. Stein will spend the winter in Ellesmereland, and will be accompanied by Dr. Leopold Kann, who will pay special attention to the study of terrestrial magnetism.

THE New Mexico Biological Station will be conducted this summer at Las Vegas, N. M., beginning work about June 25th. Mr. T. D. A. Cockerell will be in charge, and will be assisted by Miss W. Porter. It is also expected that two parties will undertake field-investigations in New Mexico, Professor C. L. Herrick having charge of a geological party, and Professor E. L. Hewitt of an anthropological one. Professor E. O. Wootton will also be

in the field, investigating the flora of the White Mountain region of New Mexico, which has already yielded him so many interesting novelties. Professor C. H. T. Townsend and Mr. C. M. Barber are collecting in the region of the Sierra Madre Mountains, in northern Mexico.

PROFESSOR W. A. SETCHELL, of the University of California, and other botanists of the University, are about to leave on an expedition to study the flora of the Aleutian Islands.

* Two French explorers have returned to Paris, Dr. Macclaud, who had been in French Guinea, and M. Peroy, who has been for three years in Gen-Thé and Cai-Binh.

MR. CHARLES H. SENFF has given \$5,000 to the zoological department of Columbia University for purposes of exploration and publication. Mr. Harrington and Mr. Sumner expect, with the assistance of this fund, to make a second expedition to the Nile in search of *Polypterus*, if the unsettled political conditions make this possible. The fund will also be used for the publication of a memoir on the anatomy of *Polypterus*, to be undertaken conjointly by Messrs. Dean, Harrington, McGregor, Strong, Herrick and Professor Wheeler, of the University of Chicago. Professor E. B. Wilson, after ascertaining last spring that the trip to Khartoum was impracticable, established a temporary laboratory at Mansourah, upon the lower Nile, the point visited by Messrs. Harrington and Hunt last summer. The fishermen assured him that *Polypterus* would return in quantity, and raised his hopes greatly; but, when after a long period, the fish began to appear it was ascertained that all the females had spawned, so that further efforts to obtain the eggs would be futile during the remainder of the season. Professor Wilson is now occupying the Columbia University table at Naples and is engaged in the revision for the third edition of his volume, 'The Cell,' which is to be translated into Italian and French.

THE Peabody Museum, of Harvard University, has received from the heirs of the late Moses D. Kimball a valuable collection of archaeological and ethnological specimens.

AT a meeting of the British Astronomical Association on May 31st Mr. E. Walter Maun-

der announced that the report of the eclipse expeditions of last year were now far advanced and were expected to be issued before the next meeting. With regard to the arrangements of the expeditions for next year, they had not yet entered into a contract with any steamship company, but they were carrying on negotiations in that direction. They expected to arrange without difficulty for a steamship to take a party out from England, leaving approximately a fortnight before the eclipse, and reaching England again about a week after it. It would probably call at some port in Portugal—either Oporto or Lisbon—then, perhaps, at Cadiz and Alicante, finally going to Algiers, where the steamer could be used as a hotel by those members of the party who went the full journey. They had received 109 names so far for the European and Algerian expedition, and additions to that number were expected.

THE University of the State of New York has just issued a museum bulletin by the State Entomologist, Dr. Felt, on *Shade Tree Pests*. Those likely to prove most destructive this season are described and depicted in various stages, and directions for the most effective means of exterminating them are given. This bulletin, No. 27, will be sent to any address for five cents. State Paleontologist Dr. John M. Clarke has prepared a *Guide to excursions in the fossiliferous rocks of New York* (University Hand-book 15), which will be of special interest to teachers and students wishing to acquaint themselves more intimately with the classic rocks of this State. Itineraries of 32 trips are given, covering nearly the entire series of paleozoic rocks, with careful details as to typical localities, how to get to them without loss of time and comfort, what strata and fossils to look for and where to find them. It is hoped to send this hand-book to all the schools in the University before the end of the school year.

AMONG important American scientific books announced for early publication are the 'Races of Europe,' by Professor W. Z. Ripley (Appletons) based on the series of articles published in the *Popular Science Monthly*; and 'Statistical Methods with Special Reference to Biological Variation,' by Dr. C. B. Davenport (Wiley), de-

scribing the statistical methods elaborated by Galton and Pearson and their application in the natural sciences.

ACCORDING to the *Boston Transcript* the University of Chicago has set aside \$5,000 to defray the expenses of explorations which are about to be conducted under its auspices in Yucatan. A collection of hitherto-unknown ruins has been discovered lately some distance southeast of the city of Merida, on the north coast, and a representative of the institution paid a visit to the spot this winter. He found the remains of what seemed to be an enormous tribal dwelling, with buildings scattered around it over an area of nearly a mile. The main edifice was built massively of stone, and the façades were literally covered with the most intricate and beautiful carving. The top is covered with earth and vegetation, and from a distance looks like a square wooded hill, so there is fairly good reason for supposing that the interior rooms are in a state of good preservation, at least that they have not been opened and ransacked by prowling Indians. There are many tombs also that have every appearance of being intact, and, if so, they may contain much matter to shed light on one of the most mysterious pages of the history of humanity. The exploring expedition will start some time within the next month, and New Orleans will be the point of departure.

A *conversazione* in connection with the meeting of the Institution of Civil Engineers, London, was given on August 9th, the guests being received by the President, Sir W. H. Preece. The *London Times* states that Sir W. Martin Conway showed a series of photographs taken during his recent expedition to the Andes, and Mr. Mansergh exhibited views in the Elan valley, illustrating the progress of the works, of which he is the engineer, for giving Birmingham a new supply of water from Wales. For those who desired still lighter amusement a number of electrophones were fitted up in connection with the theatres. Of engineering models and scientific apparatus there was a very interesting display. Among the former, which were particularly numerous, were representations of the *Powerful*, *Latona*

and *Fearless*, lent by Messrs. Vickers, Sons & Maxim; of the *Turbinia* and a torpedo-boat destroyer with a guaranteed speed of 35 knots, from the Hon. Charles A. Parsons; of the steel ice-breaking steamer *Ermak*, from Messrs. Armstrong, Whitworth & Co.; of the proposed new bridge at Kew, from Sir John Wolfe Barry; of the new high-level bridge at Newcastle, from Mr. Charles Harrison; of the new P. and O. steamer *Isis*, from Sir Thomas Sutherland; and of dredgers of various descriptions, from Messrs. J. C. Coode and William Matthews. The Royal Ordnance Factories had an interesting exhibit showing the component parts of a 303 Lee-Enfield magazine rifle and the stages in the manufacture of a solid-drawn 6-inch cartridge case. The Cambridge Scientific Instrument Company showed some specimens of Professor Callendar's beautiful electrical recording instruments. One was arranged as a pyrometer recording the variations in the radiation from an ordinary incandescent lamp, and it was very curious to see the constant alterations in the readings with minute fluctuations in the current when the eye could perceive no change whatever in the lamp. The same firm also showed the seismograph, designed by Professor Ewing, and Mr. W. Duddell's oscillograph for tracing alternate-current wave forms. Another model in action that attracted considerable notice was Professor Dunkerley's machine to illustrate the whirling and vibration of shafts in rapid rotation. Among the railway exhibits may be mentioned examples of Mr. James Holden's liquid fuel burner for locomotives, as successfully used on the Great Eastern Railway; an interesting series of rail sections from Mr. W. Dean, illustrating the development of the permanent way on the Great Western; and a working model of a magnetic system of train signalling from Mr. W. S. Boulton.

UNIVERSITY AND EDUCATIONAL NEWS.

THE gift of Mr. B. N. Duke, of the American Tobacco Company, to Trinity College, which we announced last week, makes his gifts to the College during the year \$183,000; \$6,000 of which is to improve the scientific laboratories.

The gifts of Mr. B. N. Duke and his father, Mr. W. Duke, to Trinity College have aggregated over half a million dollars in the last six years.

THE sum of twenty-five thousand dollars has been offered by an anonymous friend to Vassar College for a biological laboratory on condition another \$25,000 be collected for the purpose.

By the death of Mrs. Jeremiah Halsey the Norwich Free Academy will receive a bequest of nearly \$100,000, and Trinity College, Hartford, \$20,000, according to the provisions made by Mr. Halsey in his will.

THE Rev. H. Latham, Master of Trinity Hall, Cambridge University, has given £2,000 for the proposed Sedgwick Memorial Museum.

MISS SUSAN DYCKMANN has given \$300 for a scholarship in zoology in Columbia University for the year 1899.

THE class of 1899 of the University of Pennsylvania has given the University \$5,000 toward a scholarship in memory of the late Professor E. Otis Kendall, for many years professor of mathematics.

THE Thirty-seventh University Convocation of the State of New York will be held at Albany, beginning June 26th. President Harper, of the University of Chicago, will make the annual address, his subject being 'Waste in Education.'

At the recent Commencement, on June 8th, the University of Nebraska conferred the following degrees:

Bachelor of Arts.....	84
Bachelor of Science.....	32
Bachelor of Laws.....	51
Master of Arts.....	14
Doctor of Philosophy.....	1

The degree of Doctor of Philosophy was conferred for work in mathematics, Dr. Engberg's thesis including a study of (1st) The Cartesian Oval, and (2d) An Extension in the Theory of the Characteristics of Evolutes. The following are the titles of the theses in science presented for the degree of Master of Arts:

'The Demagnetizing Effects of Currents in Iron when electro-magnetically compensated,' by Z. E. Crook.

'Beta-Phenyl-Meta-Nitroglutaric Acid and Derivatives,' by Mariel C. Gere.

'Studies on the Genus *Cittotenia*,' R. A. Lyman.

'A volumetric Method for the quantitative Estimation of Sulphuric Acid,' by Y. Nikaido.

'A Contribution to the Chemistry of Aromatic Glutaric Acids,' by H. C. Parmelee.

PROFESSOR BENJAMIN IDE WHEELER, who holds the chair of Greek and comparative philology in Cornell University, has been elected President of the University of California.

At a recent meeting of the Board of Control of the Michigan College of Mines, Professor Fred W. McNair was unanimously elected President of the institution. Professor McNair has been for some years in charge of the department of mathematics and physics, and so closely identified with the work and growth of the College that its history, aims and methods are entirely familiar to him.

DR. F. STRONG, of Yale University, has been elected President of the University of Oregon.

MR. ULYSSES S. GRANT, of the Minnesota State Geological Survey, has been appointed professor of geology in the Northwestern University.

MR. FRANK R. LILLIE, instructor in zoology in the University of Michigan, has been appointed professor of biology at Vassar College. At the same College Miss Winnifred J. Robinson has been made instructor in biology and Miss Caroline E. Furness, Ph.D., assistant in the observatory.

At Syracuse University, Mr. S. M. Taylor has been made associate professor of physics; Dr. Henry M. Smith, instructor in chemistry, and John G. Coulter, instructor in botany.

CARL A. BESSEY, A.B., and B.Sc. in Electrical Engineering, of the University of Nebraska, has been appointed assistant professor in the department of mechanic arts in the Agricultural and Mechanical College, Stillwater, Oklahoma.

FELLOWSHIPS at Bryn Mawr College have been given to Miss Elizabeth Towle in biology, and to Miss Anna L. Wilkinson in mathematics. The fellowship in physics has not yet been awarded.

SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; J. LE CONTE, Geology; W. M. DAVIS, Physiography; HENRY F. OSBORN, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; J. McKEEN CATTELL, Psychology; DANIEL G. BRINTON, J. W. POWELL, Anthropology.

FRIDAY, JUNE 30, 1899.

LORD KELVIN'S ADDRESS ON THE AGE OF
THE EARTH AS AN ABODE FITTED
FOR LIFE.*

I.

CONTENTS:

<i>Lord Kelvin's Address on the Age of the Earth as an Abode fitted for Life (I):</i> PROFESSOR T. C. CHAMBERLIN.....	889
<i>Perspective Illusions from the Use of Myopic Glasses:</i> DR. ROBERT MACDOUGALL.....	901
<i>Birds as Weed Destroyers:</i> DR. SYLVESTER D. JUDD.....	905
<i>The Biology of the Great Lakes:</i> PROFESSOR JACOB REIGHARD.....	906
<i>The International Catalogue of Scientific Literature:—</i>	
<i>Geology and Geography:</i> PROFESSOR N. S. SHALER.....	907
<i>Physiology:</i> PROFESSOR JACQUES LOEB.....	908
<i>Scientific Books:—</i>	
<i>James's Talks to Teachers on Psychology:</i> PROFESSOR CHARLES DEGAUMO. <i>Wetterprognosen und Wetterberichte des XV. und XVI. Jahrhunderts:</i> DR. A. L. ROTCH. <i>Books Received</i>	909
<i>Scientific Journals and Articles</i>	911
<i>Societies and Academies:—</i>	
<i>The New York Academy of Sciences—Section of Biology:</i> PROFESSOR FRANCIS E. LLOYD.	
<i>The New York Section of the American Chemical Society:</i> DR. DURAND WOODMAN. <i>The Washington Botanical Club:</i> DR. CHARLES LOUIS POLLARD.....	912
<i>Professor Dewar on Liquid Hydrogen</i>	914
<i>Automatic Ship-Propulsion:</i> R. H. T.....	915
<i>Remasurement of the Arc of Peru</i>	916
<i>Leland Stanford Jr. University</i>	916
<i>Scientific Notes and News</i>	917
<i>University and Educational News</i>	919

In the early half of the century, when the more sober modes of interpreting geological data were struggling to displace the cataclysmic extravagances of more primitive times, it is not strange that there should have arisen, as a natural outgrowth of the contest, an ultra-uniformitarianism which demanded for the evolution of the earth an immeasurable lapse of time. It is not remarkable that individual geologists here and there, reacting impatiently against the restraints of stunted time-limits imposed on traditional grounds, should have inconsiderately cast aside all time limitations. It was not unnatural that the earlier uniformitarians, not yet fully emancipated from inherited impressions regarding the endurance of rocks and the immutability of the 'everlasting hills,' should have entertained extreme notions of the slowness of geological processes and have sought compensation in excessive postulates of time. Natural as these reactions from primitive restrictions were, a reaction from them in turn was inevitable. This reaction must have ensued, in the nature of the case, whensoever geologists came seriously to consider those special phenomena which point to

MSB. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

*This JOURNAL, May 12, pp. 665-674, and May 19, pp. 704-711.

limitations of time. But in the earlier part of the century geological attention was absorbed in the great phenomena that testify to the vastness of the earth's history. The time for the study of limitations had not come.

Nevertheless, however inevitable must have been the ultimate recognition of limitations, it remains to be frankly and gratefully acknowledged that the contributions of Lord Kelvin, based on physical data, have been most powerful influences in hastening and guiding the reaction against the extravagant time-postulates of some of the earlier geologists. With little doubt, these contributions have been the most potent agency of the last three decades in restraining reckless drafts on the bank of time. Geology owes immeasurable obligation to this eminent physicist for the deep interest he has taken in its problems and for the profound impulse which his masterly computations and his trenchant criticisms have given to broader and sounder modes of inquiry.

At the same time, it must be recognized that any one line of reasoning, however logically and rigorously followed, is quite sure to lead astray if it starts from limited and uncertain premises. It is an easy error to press the implications of any single phase of the complex phenomena of geology until they shall become scarcely less misleading than the looser speculations which they seek to replace. A physical deduction which postulates an excessively short geological history may as easily lead to false views as did the reckless license of earlier times. Interpretations of geological and biological phenomena made under the duress of physical deductions, unless the duress be certainly known to be imperative, may delay the final attainment of the real truth scarcely less effectually than interpretations made on independent grounds in complete negligence of the testimony of physics. It is in the last degree important

that physical deductions and speculations should be regarded as positive limitations only so far as they are strictly demonstrative. Falling short of demonstration, they are worthy to be regarded as moral limitations only so far as they approach moral certainty. In so far as they are drawn from doubtful assumptions, they are as obviously to be placed in the common category of speculations as are those tentative conceptions which are confessedly but the possible foreshadowings of truth. The fascinating impressiveness of rigorous mathematical analysis, with its atmosphere of precision and elegance, should not blind us to the defects of the premises that condition the whole process. There is, perhaps, no beguilement more insidious and dangerous than an elaborate and elegant mathematical process built upon unfortified premises.

Lord Kelvin's address is permeated with an air of retrospective triumph and a tone of prophetic assurance. The former is fairly warranted to the extent that his attack was directed against the ultra wing of the uniformitarian school of the earlier decades. It might be wholesome, however, to remember that there were other camps in Israel even then. There were ultra-conservatives in chronology as well as ultra-radicals. There were ultra-catastrophists as well as ultra-uniformitarians. Lord Kelvin's contributions have as signally failed to sustain the former as they have signally succeeded in overthrowing the latter. The great body of serious geologists have moved forward neither by the right flank nor by the left, but on median lines. These lines have lain, I think, rather in the field of a qualified uniformitarianism than in the field of catastrophism. Even the doctrine of special acceleration in early times, or at other times, has made only qualified progress toward universal acceptance. The body of competent geologists to-day are probably more nearly dis-

ciples of Hutton, Playfair and Lyell than of their opponents. But such is the freedom and the diversity of belief, of attitude and of method, among geologists that *as a class* they cannot be placed either here or there in the schools, nor could they thirty-five years ago.

But we are not primarily concerned with these matters of the schools and of the past. The address presses upon our attention matters of present interest and of profound importance. Referring to his former wide-ranged estimate of the time of the consolidation of the earth, Lord Kelvin says that "we now have good reason for judging that it was more than twenty and less than forty million years ago, and probably much nearer twenty than forty (This JOURNAL, May 12, p. 271), and he gives qualified approval to Clarence King's estimate of twenty-four million years. In the course of the address he speaks of 'strict limitations,' of 'sure assumption,' of 'certain truth,' and of 'no other possible alternative;' he speaks of 'one year after freezing,' and even of 'half an hour after the solidification'; he speaks of 'a crust of primeval granite,' of a depth of 'several centimeters,' and of other details of dimension and of time and of certitude so specifically and so confidently that it must encourage, in the average reader, the impression that the history of the earth is already passing into a precise science through the good offices of physical deduction. Is this really true? Can the uninstructed layman or the young geologist safely repose confidence in these or any other chronological conclusions as determinate? Can these definite statements, bearing so much the air of irrefutable truth, be allowed to pass without challenge? What is their real nature and their true degree of certitude when tested respecting their fundamental postulates and their basal assumptions?

With admirable frankness Lord Kelvin

says (This JOURNAL, May 12, p. 672): "All these reckonings of the history of underground heat, the details of which I am sure you do not wish me to put before you at present, are founded on the very sure assumption that the material of our present solid earth all round its surface was at one time a white-hot liquid." It is here candidly revealed that the most essential factor in his reasonings rests ultimately upon an *assumption*, an assumption which, to be sure, he regards as 'very sure,' but still an assumption. The alternatives to this assumption are not considered. The method of multiple working hypotheses, which is peculiarly imperative when assumptions are involved, is quite ignored. I beg leave to challenge the certitude of this assumption of a white-hot liquid earth, current as it is among geologists, alike with astronomers and physicists. Though but an understudent of physics, I venture to challenge it on the basis of physical laws and physical antecedents.

By way of preface it may be remarked that the postulate of a white-hot liquid earth does not rest on any *conclusive* geological evidence, however generally it may be entertained as a probable hypothesis. Students of the oldest known rocks are not yet agreed that these are all igneous even. But granting that they may be all either igneous or pyroclastic, there is a wide logical gap between this admission and the postulate that they were all liquid *at one time* and enveloped the whole earth. Looking quite in the opposite direction is the testimony of the complex structure and intricate combination of rocks, diverse at once in chemical, mineralogical and structural characters, which the basement complex presents. The relations of the great batholite-like masses to the enveloping foliated rocks, and of analogous combinations of intrusive aspect, imply the presence of a portion of the basement complex in the already solid state when

the remainder entered it in the liquid state. It would be a bold petrologist who would insist that it has been demonstrated that the basement complex is simply the molten envelope of the primitive earth solidified *in situ*, however much he might be disposed to entertain this view among his working hypotheses. It would be petrological hardihood to maintain that it was even a 'sure assumption.' Without denying that the basement complex may be the direct or the indirect offspring of a supposed molten state, no dogma of certitude is now admissible on geological grounds.

The hypothesis of a primitive molten earth is chiefly a deduction from the high internal temperature and from the nebular hypothesis. But it remains to be shown that the high internal temperature may not also be a sequence of an earth which grew up by meteoric accretion with sufficient slowness to remain essentially solid at all stages. An attempt has recently been made to show that a highly-heated state of the interior of the earth would have resulted from the self-compression of the mass during its accretion.† The methods of reasoning employed in this attempt were identical with those of Helmholtz relative to the heat of the sun, save that they were applied to a solid body. The computations of Mr. Moulton seem to indicate that gravitative concentration may have been an adequate cause of internal heat. In addition to this the thermal effect of molecular change and tidal kneading require recognition. Until these agencies are rigorously tested and found wanting, inferences based on the alternative hypothesis can scarcely be the ground of sure assumption. The irregular distribution of internal heat is more notably in harmony with the hypothesis of internal compressive generation

than with that which makes it a residuum of a molten state whose temperature should be approximately uniform. If this irregularity be assigned to volcanic action it must be remembered that vulcanism is itself a part of the irregularity and adds to the burden of explication. Both hypotheses ultimately appeal to the same source, the gravitative descent of the earth's substance. Their differences lie in the modes of action assumed respectively, and these modes are determined by the antecedent conditions of aggregation. Has it been demonstrated that these antecedent conditions were of the one kind and not of the other?

Lord Kelvin obviously assumes a nebulous state of the earth as the controlling antecedent condition. It is not quite clear whether he adopts the complete gaseous theory of Laplace, including the earth-moon gaseous ring, or not. Apparently, however, he has not adopted the gaseous earth-moon ring, but has substituted therefor a meteoroidal ancestry for the earth, for he says (p. 706): "Considering the almost certain truth that the earth was built up of meteorites falling together, we may follow in imagination the whole process of shrinking from gaseous nebula to liquid lava and metals, and solidification of liquid from central regions outwards." A little farther on he speaks of "the gaseous nebula which at one time constituted the matter of our present earth." Without feeling quite certain that I am not in error, I interpret these sentences to mean that the matter of the earth was in a meteoroidal condition just previous to its falling together, and that it passed into the gaseous condition as a result of the heat of impact, and that from thence it shrank into the liquid and later into the solid state. If this be correct it would be interesting to learn on what grounds the older hypothesis of a nebulous ring, once regarded as a quite sure assumption, has been abandoned, and

* A Group of Hypotheses bearing on Climatic Changes. *Jour. Geol.*, Vol. V., No. 7, Oct.-Nov., 1897, p. 670.

whether the reasons for that abandonment do not bear adversely also on this modified phase of the gaseous hypothesis. The strongest objection recently urged against the Laplacean gaseous ring is the apparent inability of the feeble gravity of such a ring to overcome the high molecular velocities of its lighter constituents at the high temperatures necessary to maintain the refractory material of the earth in a gaseous condition.* In addition to this radical objection to the gaseous earth-moon ring, there is the extreme probability that, if formed, it would cool below the temperature of volatilization of rock substance before it would concentrate into a globe.

The studies to which reference has just been made seemed to show that even in the globular form it is doubtful if the earth could be volatilized without the dissociation of its water and the loss of its hydrogen by molecular projection away from the earth. The inquiry seemed even to raise a doubt whether the vapor of water, as such, or the atmospheric gases could be retained at the temperature of rock volatilization; indeed, it seemed that the oceanic and atmospheric constituents might even be in jeopardy at the temperature of white-hot lava. Without insisting that these molecular inquiries are demonstrative—for they only profess to be preliminary—they seem, at least, to justify the radical inquiry whether the hypothesis that the earth was once a gaseous nebula can be entertained with any confidence, in the light of modern molecular physics. As an abstract proposition in physics addressed to physicists would Lord Kelvin feel free to assert that the water now on the surface of the earth would be retained within its gravitative control if the earth were heated so that its rock substance was volatilized? May I be pardoned for

inquiring whether Lord Kelvin has not joined the company of geologists and neglected some of the physical considerations that bear pertinently on the problem in hand?

But passing this point, and striking hands with Lord Kelvin in assuming "the almost certain truth that the earth was built up of meteorites falling together," what imperative reason is there for inferring a gaseous or even a white-hot liquid condition as a result? It goes without saying that the energy of impact of the falling meteorites would be sufficient, under assumable conditions, to give rise to the liquid condition and much more, but the *actual* condition that would be assumed by the earth would be dependent wholly on *the rate at which the meteorites fell in*. If they fell in simultaneously from assumable distances an intensely hot condition may be predicated with all the confidence of logical certitude. If they fell at as great intervals as they do to-day a low surface temperature may be predicated with equal certainty. If they fell in at some intermediate rate an intermediate thermal state of the surface must be postulated. No physical deduction can be more firm than that the temperature of the surface of the earth would be rigorously dependent on the *rate of infall* so far as the influence of infall alone is concerned. Before a white-hot condition can be regarded as a safe assumption it must be shown that the meteoroids would necessarily fall together *at a highly rapid rate*; otherwise the heat of individual impacts would be lost concurrently, as is now the case, and would not lead to general high temperature.

Now, has Lord Kelvin, or any other of our great teachers in physics or in astronomy, followed out to a final conclusion, by the rigorous processes of mathematics, the method and rate of aggregation of a multitude of meteorites into a planet, so as to be

* A Group of Hypotheses bearing on Climatic Changes. *Jour. Geol.*, Vol. V., No. 7, Oct.-Nov., 1897, pp. 658-668.

able to authoritatively instruct us as to the rapidity at which the ingathering would take place? Can the problem be solved at present with any such close approximation to precision as to determine whether a liquid or a gaseous state would or would not ensue? I assume that the most probable hypothesis relative to the distribution and movements of the meteorites is one that assumes that they consisted of a swarm or belt revolving about the sun in the general neighborhood of the present orbit of the earth; in other words, some form of meteoroidal substitute for the gaseous ring of the Laplacean hypothesis. The hypothesis may, doubtless, diverge much in detail, and, indeed, in some very important factors, but I assume that no radical departure from this can be entertained without endangering the peculiar relations of the earth to the rest of the solar system and the harmonious relations of the whole; without, in other words, jeopardizing the consanguinity of the planets. If a distribution of meteorites bearing any close resemblance to the Saturnian rings, the foster parents of the nebular hypothesis, be assumed, a definite problem is presented for determination. If the rings of Saturn, which are quite certainly formed of discrete solid matter, were to be enlarged so that they should lie outside Roche's limit, and so escape the sphere of specially intense tidal strain which will permit no aggregation, what reason is there to think that they would gather together precipitately? Does the tidal influence, which, within Roche's limit, is able to tear a satellite to pieces, cease instantly outside the limit and give place to a precipitate tendency to come clashing together? On the contrary, is it not difficult to demonstrate, by rigorous processes, even the method by which the meteorites will aggregate, much less their rate, or even to demonstrate that, apart from extraneous causes, they will fall together at all. Is not the presumption in

such a case favorable to a slow rather than to a rapid aggregation? If a distribution like the meteoroidal swarms that are associated with the comets of the solar system be assumed, a definite problem is set concerning which some appeal to observation is possible. Here the observed tendency is toward dispersion rather than aggregation. In either of these assumptions, or in any other assumption, the problem involves the balance between gravitative forces, revolutionary forces and tidal forces, and the gravitative forces are not simply those between the meteorites mutually, but those between the meteorites and the central solar body and the exterior planetary bodies, a complex of no mean intricacy. Is it certain that these forces would be so related to each other as to produce a swift ingathering of the whole swarm or belt, or, on the other hand, an ingathering prolonged through a considerable period? If the latter be the case (and, in the absence of demonstration, is it unreasonable to think it quite as probable as the opposite) are there any imperative grounds for assuming that a liquid state of the earth would result? Until the rate of aggregation is worked out fully and rigorously are there any moral prohibitions, strict or otherwise, to a free interpretation of geologic and biologic evidence on its own grounds? Is not the assumption of a white-hot liquid earth still quite as much on trial as any chronological inferences of the biologist or geologist?

It, of course, remains to be seen whether the alternative hypothesis of an earth grown up slowly in a cold state, or in some state less hot than that assumed in the address, would afford any relief from the limitations of time urged upon us. At first thought it would, perhaps, seem that this alternative would but intensify the limitations. Since the argument for a short history is based on the degree to which the earth is cooled, an original cold state should but hasten the

present status. But this neglects an essential factor. The question really hinges on the proportion of *potential energy convertible into heat* which remained within the earth when full grown. There is no great difference between the alternative hypotheses so far as the amount of sensible heat at the beginning of the habitable stage is concerned. For, on the one hand, the white-hot earth must have become relatively cool on the exterior before life could begin, and, on the other, it is necessary to assume a sufficiency of internal heat coming from impact and internal compression, or other changes, to produce the igneous and crystalline phenomena which the lowest rocks present. The superficial and sub-superficial temperatures in the two cases could not, therefore, have been widely different.

So far as the temperatures of the deep interior are concerned there is only recourse to hypothesis. It is probable that there would be a notable rise of temperature toward the center of the earth in either case. In a persistently liquid earth this high central temperature would be lost through convection, but if central crystallization took place at an early stage through pressure, much of the high central heat might be retained. In a meteor-built earth, solid from the beginning, very much less convectional loss would be suffered, and the central temperature would probably correspond somewhat closely to the density. The probabilities, therefore, seem somewhat to favor a higher thermal gradient toward the center in the case of the solid meteor-built earth.

But if we turn to the consideration of potential energy, there is a notable difference between the two hypothetical earths. In the liquid earth, the material must be presumed to have arranged itself according to its specific gravity, and, therefore, to have adopted a nearly complete adjustment to gravitative demands; in other words, to

have exhausted, as nearly as possible, its potential energy, i. e., its 'energy of position.' On the other hand, in an earth built up by the accretion of meteorites without free readjustment there must have been initially a heterogeneous arrangement of the heavier and lighter material throughout the whole body of the earth, except only so far as the partial liquefaction and the very slow, plastic, viscous and diffusive rearrangement of the material permitted an incipient adjustment to gravitative demands. A large amount of potential energy was, therefore, restrained, for the time being, from passing into sensible thermal energy. This potential energy thus restrained is supposed to have gradually become converted into heat as local liquefaction and viscous, molecular and massive movements permitted the sinking of the heavier material and the rise of the lighter material. This slow conversion of potential energy into sensible heat is thought to give to the slow-accretion earth a very distinct superiority over the hot liquid earth when the combined sum of sensible and potential heat is considered. The theoretical difference is capable of approximate computation, and Mr. F. R. Moulton has kindly undertaken to make the computation in a simplified hypothetical case which may give some impression of the possible order of magnitude of this factor. For the purposes of the computation the earth was assumed to have been composed of 40 % of metal with a normal surface specific gravity of 7 and 60 % of rock with a normal surface specific gravity of 3. These combined would give an earth whose average specific gravity would be only 4.6. The real specific gravity (5.6) is supposed to have been obtained by compression which would amount to about 18 %. Very likely the proportion of metal is put too high and the effect of compression too low, but the purpose of the computation is only to show the theoretical

possibilities of the case. The metal is supposed to have been originally scattered uniformly through the rock material in meteoric fashion, and to have gathered thence to the center, forcing the rock material outwards so far as necessary. The heat produced, Mr. Moulton found to be sufficient to raise the temperature of the whole earth (specific heat taken at .2) more than $3,000^{\circ}\text{C}$. The magnitude of this result is sufficient to require the careful consideration of the potential element unless the whole hypothesis can be set aside. It is large enough to cast the gravest doubt on any conclusion based on the rate of a supposed decline of internal temperature. Complete readjustment of the interior matter, however, is not postulated under the slow-accretion hypothesis. It is only assumed that a slow readjustment has been in progress throughout the geological ages and still is in progress, and that this has changed a certain amount of potential energy into sensible heat and that this heat has contributed to the maintenance of the internal temperature of the earth.

But there are in addition, incidental factors which enter effectively into the case. The gravitative readjustment of the heterogeneous interior material is presumed to have taken place by the descent of the metallic and other heavier materials toward the center and the reciprocal ascent of lighter materials from the central region toward the surface, this being accomplished in various ways, the most declared of which has its superficial manifestation in volcanic action. Now, this process of vertical transfer, beside developing heat in proportion to the work done, as above indicated, also incidentally brings the hotter material of the interior toward the surface and thus increases the subsurficial temperature. It is a species of slow convection. This convection is in no radical sense different from that which is supposed to have taken place

in the liquid earth, save that it was delayed so that the heat is available within the life era of the earth, instead of being brought to the surface and dissipated in the prezoic hot stage, when it was a barrier to the existence of life instead of an aid.

Again, in the liquid earth there were the best imaginable conditions for the intermixture of the earth constituents and for the formation of such chemical and mineral combinations as best accorded with the high pressures of the interior. In the heterogeneous solid earth, on the other hand, such combinations were restrained and delayed and have been able to take place only slowly throughout the secular intermingling of the internal material. It, therefore, hypothetically follows that throughout geological ages, as the internal material was able slowly to readjust itself, new chemical and mineral combinations become possible. These combinations would be controlled by the high pressure in the interest of maximum density, and of hypothetically possible mineral combinations, only those would form which gave the higher density.* Thus a slow process of recrystallization in the interest of greater density would be in progress throughout the ages. This denser crystallization would set free heat. It would furthermore permit the shrinkage of the whole mass and the consequent intensification of its self-gravitation and this would in turn result in further development of heat. This large possible shrinkage meets the demands of geological phenomena at a point where the liquid earth has been felt to conspicuously fail. The losses of heat from the earth, as computed by Lord Kelvin and other authorities, and the shrinkage resulting therefrom have long been held to be quite incompetent to produce the observed inequalities. Their incompetence is now

* Professor C. R. Van Hise has worked this out elaborately in manuscript not yet published.

very generally admitted by careful students. Lord Kelvin also admits this, by implication, when he says (sec. 31, p. 706) "If the shoaling of the lava ocean up to the surface had taken place everywhere at the same time, the whole surface of the consistent solid would be the dead level of the liquid lava all around, just before its depth became zero. On this supposition there seems no possibility that our present day continents could have risen to their present heights, and that the surface of the solid in its other parts could have sunk down to their present ocean depths, during the twenty or twenty-five million years which may have passed since the *consistentior status* began or during any time however long."

In addition to this recognized quantitative deficiency, the present writer has been led to question its qualitative adaptability. The phenomena of mountain wrinkling and of plateau formation, as well as the still greater phenomena of continental platforms and abysmal basins, seem to demand a more *deep-seated* agency than that which is supplied by superficial loss of heat. This proposition demands a more explicit statement than is appropriate to this place, but it must be passed by with this mere allusion. It would seem obvious, however, that an earth of heterogeneous constitution, progressively reorganizing itself, would give larger possibilities of internal shrinkage, and that this shrinkage must be deep-seated as well as superficial. In these two particulars it holds out the hope of furnishing an adequate explanation for the deformation of the earth where the hypothesis of a liquid earth seems thus far to have failed.

But the essential question here is the possibility of sustained internal temperature. It is urged that the heterogeneous, solid-built earth is superior to the liquid earth in the following particulars: (1) It retains a notable percentage of the original

potential energy of the dispersed matter, while in the liquid earth this was converted into sensible heat and lost in prezoic times; (2) it retains the conditions for a slow convection of the interior material, bringing interior heat to the surface, a function which was exhausted by the liquid earth in the freer convection of its primitive molten state; (3) it retains larger possibilities of molecular rearrangement of the matter and of the formation of new minerals of superior density, whereas the liquid earth permitted this adjustment in the prezoic stages. In short, in at least these three important particulars, the slow-built meteoric earth delayed the exercise of thermal agencies until the life era and gradually brought them into play when they were serviceable in the prolongation of the life history, whereas the liquid earth exhausted these possibilities at a time of excessive conversion of energy into heat and thus squandered its energies when they were not only of no service to the life history of the earth, but delayed its inauguration until their excesses were spent.

Let it not be supposed for a moment that I claim that the alternative hypothesis of a slow-grown earth is substantiated. It must yet pass the fiery ordeal of radical criticism at all points, but it is the logical sequence of the proposition that a swarm of meteorites revolving about the sun in independent individual orbits and having any probable form of dispersion would aggregate slowly rather than precipitately. If the astronomers and mathematicians can demonstrate that the aggregation must necessarily have been so rapid as to crowd the transformed energy of the impacts into a period much too limited to permit the radiation away of the larger part of the heat concurrently, the hypothesis will have to be set aside, and we shall be compelled to follow the deductions from the white-hot liquid earth, or find other alternatives.

But I think I do not err in assuming that mathematical computations, so far as they can approach a solution of the exceedingly complex problem, are at least quite as favorable to a slow as to a rapid aggregation. If this be so, the problem of internal temperature must be attacked on the lines of this hypothesis as well as those of the common hypothesis before any safe conclusion can be drawn from it respecting the age of the earth.

Another basis upon which the address urges the limitation of the earth's history is found in tidal friction. The limitations assigned on this basis are not, however, very restrictive. The argument is closed as follows: "Taking into account all uncertainties, whether in respect to Adams' estimate of the ratio of frictional retardation of the earth's rotary speed, or to the conditions as to the rigidity of the earth once consolidated, we may safely conclude that the earth was certainly not solid 5,000 million years ago, and was probably not solid 1,000 million years ago" (p. 670) and in a foot-note it is added: "It is probable that the date of consolidation is considerably more recent than 1,000 million years ago."

The foundations of any argument involving the relations of the moon to the earth are very infirm. In the first place, no hypothesis respecting the moon's mode of origin, or of the time in the history of the earth when it became aggregated and came into effective possession of its tidal function, can claim even a remote approach to substantiation. There is not only no substantiated theory of the origin of the moon, but there can scarcely be said to be even a good working hypothesis, for the radical reason that the hypotheses offered will not *work*. George Darwin, who has probably studied the subject more assiduously and more profoundly than any other investigator, ancient or recent, strongly expresses the situation when he says, in his recent

work on 'The Tides,' (p. 360) "The origin and earliest history of the moon must always remain highly speculative, and it seems fruitless to formulate exact theories on the subject." The annular theory of Laplace encounters in their maximum intensity the objections which arise from the application of the modern doctrine of molecular velocities. The gravitative control of an attenuated ring having the mass of the moon over its constituent material must have been exceedingly low, while the high temperature necessary to sustain the refractory material of the moon in a gaseous condition must have rendered the molecular velocities very high, so that no material except that of very high atomic weight and consequent low molecular velocity could be presumed to have been retained. But the specific gravity of the moon (3.4) seems a fatal objection to the assumption that it is composed wholly of material of very high atomic weight. Besides, it is difficult to understand how the high temperature of a ring of such attenuation could have been maintained during the time necessary for its concentration. This was less difficult when it was assumed, as formerly, that the temperature of the sun at that time was excessively high, as was also that of the earth. But modern inquiry seems decidedly opposed to the assumption of excessively high temperatures at that stage. On the contrary, it has recently been urged from different quarters that the early temperature of the sun's surface must have been much lower than at present, and this is also implied in certain statements of the address (p. 711, Sec. 43). There are also grounds for grave question as to the high temperature of the earth, as has already been indicated. Under the revised forms of the nebular hypothesis there seems no substantial reason for supposing that if the matter of the moon was once distributed in a ring about the earth, it could maintain

the gaseous condition throughout the stages of its condensation. The hypothesis therefore rests upon exceedingly doubtful premises and upon exceedingly questionable deductions from these doubtful premises.

The fission hypothesis of George Darwin has recently replaced it in favor, but the above quotation implies that even its founder does not now rest much confidence in it. The objections to the theory are several and grave. In the first place, the theory of the fission of a celestial body by high rotation, as worked out independently by Darwin and Poincaré, requires that the separated bodies should not be very greatly different in mass, *i. e.*, the smaller body should not be less than one-third the mass of the larger. But the mass of the moon is but $\frac{1}{80}$ of that of the earth, and hence it lies far outside the computed limits of applicability of the fission process.

Another difficulty lies in the effect of tidal strain itself. George Darwin, in his recent work on 'The Tides' (p. 259), assigns 11,000 miles from the center of the earth as Roche's limit. This leaves a tract of 7,000 miles above the terrestrial surface within which the earth's tidal force would be so great as to tear the moon to fragments, and, perhaps, scatter these into the form of a ring. The rings of Saturn are supposed to illustrate this form of intense tidal action. The escape of the moon, even presuming it to have been separated from the earth would, therefore, have been jeopardized by its transformation into a meteoroidal ring or swarm. If the fragments, after having been torn apart, were still sufficiently affected by a minute tide to be carried away from the earth in a slow spiral, the time occupied in passing outward beyond Roche's limit must have been protracted; and, after their escape from it into a zone where conditions not hostile to aggregation might, perhaps, have been afforded, there must probably have been

another protracted period before the aggregation of the moon would have been sufficiently advanced to give it appreciable tidal effect upon the earth. It remains, therefore, to be determined, if this hypothesis is followed, at what stage in the evolution of the moon it was sufficiently concentrated to assume effective tidal functions. This is a question also applicable to the aggregation of the moon under the Laplacean hypothesis, if it be modified so as to conform to the demands of modern scientific probability. It also applies to any hypothesis which postulates aggregation from a dispersed condition. In any case, it seems necessary to determine when the moon became full grown before it is possible to assign a positive date for the commencement of effective tidal action. It would appear that such action might be developed gradually as the material of the moon became aggregated. During such gradual assumption of the tidal function the reaction between the moon and the earth must have been of a feeble sort, and a recomputation of its amount based on a series of hypotheses which shall cover the whole ground of legitimate speculation would seem necessary before any satisfactory conclusions can be reached.

It may be urged that the computations of George Darwin following, in backward steps, by the masterly application of mathematical analysis, the stages of the earth-moon relationship give a firmer ground for conclusions. In a qualified degree this must be conceded. But it is to be remarked, in the first place, that the mathematics becomes indecisive before the origin of the moon is reached, which may signify that this is not the true line of approach to the origin of the moon, or that there is some error or defect in the assumptions. It would seem to be obvious, however, that if the tidal function was the result of a slow aggregation which began at an indetermi-

nate stage in the earth's existence the numerical results of a computation based on a full-grown moon may need radical revision.

Furthermore, the agencies which are assumed to have accelerated the rotation of the earth in its earlier history must not be neglected. If they may safely be assumed to have been competent to give the earth a rotary speed sufficient to detach from itself the matter of the moon, as is postulated in the Laplacean and the fission hypotheses in common, the same agencies, if more evenly distributed in time, might prolong the period of acceleration so that it should be coincident with that of tidal retardation and offset it in any degree that falls within the legitimate limits of assumption. We encounter here again, in another form, a deduction from the assumption of a very rapid concentration of the matter ingathered to form the earth and moon, and the consequent exhaustion of its energy in an early stage. If, however, the concentration were less rapid and less complete in the early history of the earth, as is postulated by the accretion theory, as herein entertained, acceleration might be far less advanced in the earliest stages and be greater in the later stages. Hence the retarding effects of tidal friction may have been more effectually antagonized by the shrinkage of the earth during the progress of geological history. Mr. Moulton has computed the effects of the internal change of metal and rock material, assumed in a hypothetical case on a previous page, on the speed of rotation of the earth, and found that it would accelerate the then-current rate, whatever it was, about one fifth. If, therefore, the delayed central concentration left some notable part of the acceleration to be gained during the period of geological history, and if, at the same time, a slow aggregation of the moon delayed its effectual tidal influence upon the earth and

the reciprocal influence of the earth upon it, the whole history may be notably affected in the direction at once of less maximum speed and of less retardation, *i. e.*, of more near approach to uniformity.

If we turn to the geological data that bear on the question of former high rotation and subsequent retardation we find ample support for profound skepticism regarding the applicability of the tidal argument. As pointed out by Lord Kelvin, if the rotation of the earth were once notably greater than at present it should have resulted in an oblateness of the spheroid such that the equatorial regions would now be all dry land, unless the body of the earth were deformed to correspond to the slackening rotation in an almost perfect manner. But there is not the slightest evidence in the configuration of the earth of such an equatorial land tract. The equatorial belt is notably oceanic rather than otherwise. Reciprocally, there should have been, with the gradual slackening of the earth's rotation, an accumulation of the oceanic waters about the poles, but there is no geological evidence of such an accumulation in any appreciable degree. In the Arctic regions, as exemplified in Greenland, Spitzbergen and the Arctic islands of America, there are ancient shallow water deposits which lie both above and below the present oceanic level. These deposits range throughout the Paleozoic and represent in some less degree both the Mesozoic and Cenozoic eras. The nature of these shallow-water deposits is such that they cannot have been formed at great depths below the oceanic surface, so that, with the allowance of a few hundred feet, it is possible to locate the ancient horizons relative to the crust of the earth, at most or all of these periods. From these it may be inferred with great confidence that the ancient ocean surface in the Arctic regions was in numerous stages of Paleozoic, Mesozoic and Cenozoic

eras not notably different from that of today. The facts even justify the seemingly extravagant statement that at several stages in geological history, early and late, the surface of the ancient ocean did not vary a foot from that of the present, since it must have passed both above and below the present horizon repeatedly during the earth's history. Geological evidence, therefore, interpreted on its own legitimate basis, seems to lend no appreciable support to any theory that postulates a high speed of rotation for the early earth, or a low speed of rotation for the present earth, unless that hypothesis is correlated with the assumption of an almost perfect adjustability of the form of the earth to the changing rotation, in which case the argument of Lord Kelvin set forth on p. 670 stands confessedly for naught.

If we postulate a slow accretion of the earth and of the moon alike, the whole subject of the former speed of rotation of the earth and the relations of the earth to the moon take on a new aspect and invite investigation along the lines of new working hypotheses. Can it be shown that it is absolutely necessary that the aggregating meteoroids gave to the earth an exceedingly high rotation at the outset? Is not this assumption of high rotation merely an offspring of the nebular hypothesis? If the moon were aggregated slowly and came into tidal functions at a late stage, and at a distance from the earth's center quite unknown, may not all its relations to the earth have developed on much more conservative lines than those worked out by Darwin and at the same time preserve those apparently significant relations to the movements of the two bodies to which Darwin has so strongly appealed in support of his hypothesis of the history of the two bodies? In other words, without challenging the validity of Darwin's most beautiful investigation in the essentials of its method,

may not a change in the premises deducible from an equally legitimate hypothesis of the original condition of the two bodies lead to results in equally satisfactory accord with the existing relations of the two bodies?

At any rate, as remarked at the outset, the time-limits assigned on tidal grounds are not very restrictive, even on the assumptions made, and when they shall be worked out on revised data in accord with the newer hypotheses they may, perhaps, even be found to favor the longevity of the earth and become one of the arguments in support of it.

T. C. CHAMBERLIN.

UNIVERSITY OF CHICAGO.

(*To be concluded.*)

PERSPECTIVE ILLUSIONS FROM THE USE OF MYOPIC GLASSES.

THE phenomena to be described occurred during the first days' use of myopic glasses, and may be grouped under the following heads:

a. There was an apparent diminution in size of moving objects—persons, animals, street cars—as compared with buildings, natural scenery, and, in general, with the elements of the background of the visual field. Here the total visual fields of the normal and of the myopic eye are equally extensive; there are the same number of projection points in each. Over this background, in the case of a myopic individual, there is distributed a relatively small number of distinct and at the same time interesting or important objects. When the near-sighted person puts on powerful glasses the number of such important and interesting distinct objects thrown upon this background is vastly increased; it is crowded with a multitude of persons, animals, trees, buildings, and the like. There are here two sets of factors whose interpretation in terms of perspective point in divergent directions. Multiplicity of objects in the visual field

means farness of the observer from the things viewed, while definiteness of detail in the individual object means nearness in point of view. In the given case there is, relatively to the number of discernible objects, an abnormal distinctness, or, relatively to their definition, an abnormally great number of objects. Adoption of the one as criterion will lead to an underestimation of size; adoption of the other will result in an overestimation of distance. The former actually obtains, and for this reason as it appears.

The dominant factor of the change in character of visual objects here is the increased distinctness of them at any given distance—the greater definiteness of line and shadow, the elaboration of detail. Such distinctness of form means in general nearness of the object to the observer. Now the near object in order to be seen as a total, a unity, must be comparatively small. The arrangement of a garden plot cannot be grasped while one walks along its paths as when viewed from a window overlooking it; the course of a river can be apprehended only when seen from some neighboring height. The same holds true of smaller as of larger groups of elements—the observer must step back in order to get the general effect—*i. e.*, to appreciate the factors as a total object. The more complex or grander the proportions of an object the farther away must be the point of view from which it can be grasped as a unity. If, then, it is so to be apprehended while yet near to the observer its parts must be small and simple. In the case in question the effect of the new glasses was thus to increase the definiteness of detail in visual objects, while these objects were still regarded as totals, a combination directly tending to produce that sense of smallness in the individual object which was actually noticed.

Another fact points in the same direction. Of curved surfaces a large radial extent

can be seen distinctly by the myopic eye only when the object is a small one, and, therefore, not greatly affected by the parallax angle. Of equally distinct objects, therefore (which in the two cases will be at different distances), the myopic subject sees less curvative-extent than the normal; or, for two equally distinct objects in the myopic field of view (which are, therefore, at the same distance from the eye) greater visible extent of curvature means smallness of size. By the use of the new glasses the extent of visible curvature was thus increased, while the distinctness of the objects' details remained unaffected. This influence, therefore, coöperated with the preceding to produce the feeling of unnatural smallness in the nearer objects of vision.

b. The change in relative curvature-extent visible from the point of distinct vision appears to have been active in the production of another perspective illusion, the exaggeration of curvature in objects bounded by convex surfaces. The cheek or brow of a person, for example, appeared to bulge out unduly in the middle, and there was a constant tendency to put out the hand and test by touch the accuracy of the sight perception. In the myopic eye the point of view of distinct vision lies so near to its object that for any given group of things the perceived curvature extent is small in comparison with that visible to the normal eye. In objects beyond the range of distinct vision, when such are not overlooked and referred to the unnoticed background, the curvature gradations are obscured and the myopic eye must depend upon other cues for its interpretation of convexity degree. It reinforces the perception by contributed curvature elements. When the finer gradations of curvature are restored to sight by the stronger glasses the contributed emphasis appears to be continued, with the result of an apparent exaggeration of curvature. I have not had

opportunity to observe if in the case of concave surfaces there is an analogous exaggeration of hollowness or depth.

c. The use of stronger glasses produced an apparent diminution in the perspective relations of objects within the visual field, which at times reached almost the vanishing point. Men and women on the street were silhouetted against the background of trees and houses, or moved like shadows over a screen. A similar reduction in perspective can be produced by piercing a bit of cardboard with a small hole, and viewing a group of objects in the middle distance through it, while the cardboard is held close to the eye. The fineness and certainty of distance perception depend greatly upon the continuity of the visual field from the feet of the observer to the object viewed, and in the last mentioned case the obscuration of this sense is due to the interruption of these conditions. In the case of myopic glasses the illusion is due, in part at least, to an underestimation of the distance of the objects, resulting from their abnormal definition as seen through the stronger glasses. In any series of uniformly spaced objects the apparent size and the visual distance between any two adjacent members decreases as their absolute distance from the eye increases. In all normal cases this decrease is correctly interpreted through the coördinated perception of increased distance. If, however, an illusion of increased nearness to the observer arises from any cause, not only do the objects themselves appear smaller, but the relative distances between them are likewise reduced, and the perspective of the field of individualized objects thereby diminished.

d. The faces of persons in the middle distance—that is, towards the farther limit of distinct vision for the character of the facial lines and expression—appeared to hang in the air near by when first caught sight of. Here the distance of the object

appears to have been estimated correctly by the use of various familiar criteria, chiefly the multiplicity of objects between the observer and the person seen. When, however, the eye first rested upon the face of the person in question these cues fell into the background and the abnormal definition of the face became the dominant factor of the experience, a definition possible to the unaided myopic eye only within a much narrower range of vision; and the shock of contradiction between the felt distance of the object and its observed distinctness resulted in a dissociation of the face image from that of the rest of the body, the latter maintaining its estimated distance, the former approaching to that corresponding habitually with the observed definition. The illusion maintained itself only during a few moments while the attention was strongly centered on the face.

e. This focussing of attention upon the face had itself an abnormal element in it. The faces of persons at a distance appeared mask-like and grotesque; the eyes stared, the light and shadow fell unnaturally, the lines and expression were distorted. Subjectively this change was manifested chiefly as an alteration in the affective overtone of the object, but one which itself is derived from a change in the character of the perception. The magnitude of the visual angle which any object subtends varies with its distance from the observer. As this distance changes, the mechanism of the eye must be adjusted to keep the object in the focus of distinct vision. Up to a certain point this is possible, but beyond that limit accommodation of the eye must be replaced by approach of the point of view toward its object. The latter form of adjustment is habitual with the myopic eye as compared with the normal. In consequence the angle which the object of distinct vision subtends in the case of the myopic eye is habitually greater than in that of the normal eye. It

always sees things at a different angle—in other words, it sees a different *thing*. Suppose that for the normal eye A and the myopic eye B the ranges of distinct vision be respectively $a\ b\ c$ and $b\ c$, and that there be viewed an object consisting of a set of plane surfaces at right angles to the line of vision of the normal eye and a second set coincident with it. The normal eye will habitually see only the set of plane surfaces at right angles to its axis of vision, and at successively greater distances from its point of view; while the myopic eye, observing the same object, will not only regard these planes at a different angle, but will see also the surfaces connecting the extremities of the first mentioned planes. In other words, the two eyes will have before them different sets of visual elements. The same principle applies in detail to all objects of distinct vision; therefore, as the point of view changes to a new focal distance from normal to myopic, or the reverse, the constituents of the visual field are altered and an accent of strangeness and unfamiliarity is given to its objects. This matter of focal distance becomes of distinct importance in photography, where the space relations of camera and object must be as nearly as possible those under which the picture will afterward be viewed; otherwise a distortion of perspective appears which materially interferes with the truth of the representation.

f. There is a final group of changes in visual perception to be considered in connection with concomitant motor adjustments. These consist, in the first place, of deflections and curvatures of right lines when viewed through the marginal areas of the glasses, which are obviously due to the non-homogeneous refractive qualities of the lens. They are identical with the distortion of vertical lines upon the sides of the visual field in a photograph the focal distance of which is short in relation to the

length of these lines. The divisions of the sidewalk, the rails of the car tracks, and all lines whose direction lies at right angles to that of vision, are thus warped from the rectilinear. The same is true of house-walls and trees, and of all vertical lines at the sides of the visual field. When coming down a flight of stairs the steps curve forward at the sides, making them appear a semicircular, hollow flight.

The result of these changes is a confusion of the relations between visual perception and motor adjustment. The familiar visual cues by which the latter is habitually governed have been destroyed, and movements are awkward and mal-adjusted. It is impossible to walk down a familiar flight of steps without stumbling repeatedly. The illusionary reduction in visual size and foreshortening of perspective work disastrously here, and result in a short, mincing step which brings the foot constantly into collision with the step from which it is descending, instead of allowing it to clear for the next. There is an absolute contradiction between visual measurement and motor adjustment. The only way to secure such adjustment and reach the bottom in safety is to look quite away from the steps and to trust wholly to joint and limb perception. Thus the connections of muscular memory become the controlling cues, uncontradicted by present visual impressions, and the descent grows at once secure and rapid.

Secondly, the shortening of perspective is not uniform for all areas of the lens, but increases continuously from the margin towards the center. The effect of this appears in a curious optical illusion and a second form of mal-adjustment of motor reaction in consequence of it. The ground in front, as one walks, appears constantly to rise in a sharp curve, as if a steep hill were being mounted, and the foot is raised to meet the imaginary elevation, only to be brought down again with a shock to the original

level. It is a continual repetition of taking a step too many at the top of the stairs.

The most strongly marked characteristics of the whole experience lay in the change wrought in the affective overtone of perceptual objects in the suggestion of new touch-qualities and impulses, and the existence of abnormal emotional attitudes, but these matters lie too far afield to be considered in the present paper.

ROBERT MACDOUGALL.

HARVARD UNIVERSITY.

BIRDS AS WEED DESTROYERS.*

A MILLION weeds can spring up on a single acre. Cultivation will do much to eradicate these noxious plants, but some will always succeed in ripening a multitude of seeds to sprout the following season, so as to make tilling the soil an everlasting war against weeds. Certain garden weeds produce an incredible number of seeds. Thus a single plant of purslane may mature a hundred thousand seeds in the fall, and if unchecked would produce in the spring of the third year ten billion plants.

Probably the most efficient check upon this unbounded increase of seeds is to be found in the seed-eating birds which flock by myriads to agricultural districts to feed upon the bounty of the weed-seed harvest from early autumn until late spring. Since birds attack weeds in the most critical stage of the plant cycle, it follows that their services will be of actual practical value. The benefits are greatest in case of hoed crops, since here found the largest number of annual weeds, which, of course, are killed by frost and must depend for perpetuation solely upon their seeds. Seed-eating species of birds prevent, in a large measure, weeds of this class, such as, for instance, ragweed, chickweed, purslane, crab grass, pigweed,

* Birds as Weed Destroyers. Year-book of Department of Agriculture for 1898, pp. 221-232 inclusive.

lamb's quarters and several weeds of the genus *Polygonum*, from seeding down the land with a rank vegetation fatal to cultivated crops. The problem of weed destruction is of such magnitude that Mr. F. V. Coville, Botanist of the United States Department of Agriculture, in discussing weed legislation, has said, * * * "Since the total value of our principal field crops for the year 1893 was \$1,760,489,273, an increase of only 1 per cent., which might easily have been brought about through the destruction of weeds, would have meant a saving to the farmers of the nation of \$17,000,000 during that year alone."

The birds most actively engaged in consuming weed seed are horned larks, black-birds, cowbirds, meadow larks, doves, quail, finches and sparrows. In a field sparrow's stomach I found 100 seeds of crab grass, in a snowflake's stomach 1,000 seeds of pigweed, and in a mourning dove's crop 7,500 seeds of *Oxalis stricta*. That the destruction of weed seed by birds is extensive enough to be of considerable benefit to the farmer is shown by Professor F. E. L. Beal, who estimated that in the State of Iowa alone a single species, the tree sparrow, consumes annually 875 tons of weed seed.

From the examination of the stomachs of some 4,000 birds it has been determined that the best weed destroyers are the goldfinches, grosbeaks and a dozen species of native sparrows.

In cities the English sparrow, assisted by several native species, does good work by feeding upon the seeds of lawn weeds, such as crab grass, pigeon grass, chickweed and the dandelion. On the lawns of the Department of Agriculture, in Washington, the birds feed upon dandelions from the middle of March until the middle of August. After the yellow petal-like corollas have disappeared, and the flower presents an elongated egg-shaped body, with a downy tuft at the upper end, the sparrow re-

moves several long scales of the inner involucre by a clean cut close to the receptacle, thus exposing the plumed akenes, and then seizes a mouthful of these between the plumes and 'seeds,' lopping off the plumed pappus and swallowing the 'seeds.' The mutilation of the involucre by the sparrow's beak can be seen until the flower stalk dries and falls. Fully three-fourths of the dandelions that bloomed on the Department grounds during April and May, 1898, were mutilated by birds.

The English sparrow, in spite of the services it renders in consuming weed seed, is a pest because of its despoiling buildings, and because of its extensive pillaging of fruit and grain. The native sparrows, on the contrary, have no such noxious habits, and are much more efficient as weed-seed destroyers.

The several species of goldfinches are equally beneficial. The American goldfinch confines its attacks almost entirely to the *Compositæ*; the thistle, ragweed and dandelion being its favorites. Last October I observed a flock of fifty on a New Hampshire farm. A bird would alight on a bull thistle and the pappus would float away as it feasted. Under a thistle head I found over a hundred empty akenes that had been split open on one side and had their seeds removed. These goldfinches alighted, several at a time, in a single ragweed plant and fed so busily that I could approach within a few feet of them. On another day this flock of birds fed upon the evening primrose. According to Mr. H. C. Oberholser the goldfinch also feeds upon beggar ticks (*Bidens frondosa*) and milkweed (*Asclepias syriaca*).

Dr. E. V. Wilcox has observed American goldfinches in Montana feeding in flocks of fifteen to twenty on the wild sunflower, which is a very bad pest in the West. In the same State he observed Juncos and red poll linnets eating the seeds of the Russian thistle.

The goldfinches and native sparrows are more beneficial to agriculture than a number of other species, such as the English sparrow and blackbirds, which at times injure grain and fruit, but there are, however, in the work of weed-seed destruction some fifty species of birds engaged, and the number of species of weeds which they tend to eradicate amounts to more than three score.

SYLVESTER D. JUDD.

DEPARTMENT OF AGRICULTURE.

THE BIOLOGY OF THE GREAT LAKES.

SCIENCE for July 1, 1898, contained a notice by Dr. H. M. Smith, of a proposed Biological Survey of Lake Erie to be carried out under the auspices of the United States Commission of Fish and Fisheries.

Unfortunately, none of the work of the season of 1898 could be entered upon until the middle of July, and it was discontinued about the first of September. Since the work outlined in the second paragraph of Dr. Smith's notice is of such a character that it must be carried on continuously, it must wait for the establishment of a permanent biological station on the lakes.

The work that could actually be undertaken was that outlined in the third paragraph of the notice. The shortness of the time (4-6 weeks) did not permit results to be reached in many of the problems under investigation; so that the results of the summer's work so far published are contained in three papers by Dr. Jennings, a brief notice of the occurrence at Put-in-Bay of *Trochosphaera solstitialis*, contained in SCIENCE, October 21, 1898, and two papers on 'The Motor Reactions of *Paramæcium*' and the 'Laws of Chemotaxis in *Paramæcium*' in the *American Journal of Physiology*, May 1, 1899. Progress was, nevertheless, made in all the other lines of work. Some of the results are now awaiting publication.

and others will be ready for publication during the coming autumn.

During July and August, 1899, work will be continued at Put-in-Bay. The party will consist of the writer, as director; Professor H. B. Ward, of the University of Nebraska; Dr. H. S. Jennings, of Dartmouth College; Dr. Julia B. Snow, and Mr. R. H. Pond, besides a number of assistants. The members of the party will continue the work undertaken last summer, and referred to in Dr. Smith's notice, except that Mr. Pond, who takes the place of Mr. Pieters, will undertake an experimental investigation of the nutrition of the larger aquatic plants.

The entire party will work at Put-in-Bay during July. During August it is intended to divide the party. Those engaged in experimental work will remain at Put-in-Bay. The writer and Professor Ward, together with a number of assistants, to act as collectors, will make a tour of the lake for the purpose of making collections, and in order to study the distribution and constitution of the plankton in the different parts of the lake.

The locality at Put-in-Bay affords a variety of conditions and is rich in aquatic fauna and flora. The occurrence of the huge infusorian *Bursaria truncatella* and of *Trochospæra* are of especial interest.

During August it will be possible to offer the facilities of the laboratory to a limited number of investigators. The United States Commission of Fish and Fisheries will furnish all apparatus, glassware and reagents and place the entire resources of the laboratory at the disposal of such investigators without charge. Those who wish to take advantage of this opportunity should communicate with the writer at Ann Arbor, Michigan, before July 1st; at Put-in-Bay, Ohio, after July 1st.

JACOB REIGHARD.

ZOOLOGICAL LABORATORY OF THE UNIVERSITY
OF MICHIGAN, ANN ARBOR, MICH.

THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.

GEOLOGY AND GEOGRAPHY.

THE schedule of classification of writings relating to Geology and Geography which it is proposed by the International Catalogue Committee to adopt appears, on the whole, to have been well considered, though, as regards its details, it is evidently open to certain criticisms. Thus it will be noted that there is no recognition of any subdivisions of the Archæan. The matter of soils, clearly of much importance, finds no place in the list. It is hardly to be grouped under the heading of Denudation and Deposition. So, too, the matter of shore lines appears to have fairly a share in a scheme where glacial geology is ranked by itself apart. It may also be remarked that the whole field of economic geology is not suggested by any of the headings, and surely deserves recognition in any catalogue. Were this heading adopted it would naturally include a large part of the papers concerning veins and other ore deposits. As it is, these phenomena appear not to have been thought of.

Under the heading of Geography is a schedule of classification on a topographic basis, which is probably intended to serve also for the distribution of a portion at least of the works on geology, though this is not clearly stated. As a whole, the topographical classification which has been adopted commends itself to the reader. In places, however, the meaning is not clear, as in 'K Arctic: Greenland and the area north of the Arctic Circle, or all the coasts of Continental America, Asia and Europe, *whichever is farther north*' (the italics are ours). It is possible, by systematic exegesis, to arrive at some conception of what the writer meant, but at first sight it seems to imply a variable northness of these several areas. It may also be noted that the category denoted by *ea.*, viz., Asiatic Russia, is much too

large for convenience. In time a great literature will, doubtless, have to be referred to this division. The realm could be subdivided, perhaps, on the base of its drainage.

Under *gb.*, *gd.*, *ge.* and *ge.* the division is troublesome. First, we have Canada as a whole, then the Canadian Dominion west, including Yukon and British Columbia, Mackenzie, Athabaska, Alberta, Saskatchewan and Assiniboia; but *gd.*, the Canadian Dominion east, includes only Newfoundland. In this specification Labrador and the neighboring districts seem to be left out. To add to the confusion comes *ge.*, which takes in the Laurentian Lakes, with no statement as to the limits of the territory included in the category. Following down, we find, after the United States as a whole, a division which includes the northeastern field, i. e., all the States east of the Mississippi down in general to the Ohio and the Potomac, but omitting in the list Maryland and Delaware. The southeastern United States east of the Mississippi does not include a list of States. It may be intended to contain those last mentioned, but under the circumstances the names should be specified.

The subject classification under Geography is, as will be observed, much more detailed than the like grouping under Geology. It appears tolerably complete, but there again the matter of soils and of shores is omitted, though such matters as rocks, minerals and mines, which are less fitly to be regarded as geographic, find a place. It may also be noted that, while under Geology there is a 'seismic' division (including elevation and depression and mountain building), the matter of earthquakes is only mentioned in the geographic classification. We may fairly wonder whether this suggested difference in treatment was actually designed. In the geologic scheme volcanoes are included. They can come in again under

the head of volcanic phenomena under Geography. Again we wonder whether this arrangement is by chance or design.

If it is intended by this classification to demark the fields of geology and geography it is clearly open to objection from many points of view. Thus such matters as dunes, coral reefs, minerals, mines, etc., which find mention only under Geography, are, by common understanding, regarded as subjects for treatment under the head of Geology.

N. S. SHALER.

HARVARD UNIVERSITY.

PHYSIOLOGY.

THE Editor of SCIENCE has kindly asked me to comment on the physiological part of the Catalogue of Scientific Literature, prepared by the Royal Society. I should like to call attention to a few points.

1. It seems to me that the space given to *comparative physiology* is not sufficient. Physiology is undergoing the same change that has taken place in morphology. The latter science was originally confined to man and a few of the higher vertebrates, but at present scientific morphology is identical with comparative morphology. The same change is taking place in physiology. It is true that the text-books of physiology have as yet taken no notice of this change, but a catalogue of 'scientific literature' cannot afford to ignore the development of physiology. The catalogue must take into consideration the fact that *the field of comparative physiology is much wider than that of human physiology*, and that, therefore, more space and a more prominent position is necessary for comparative physiology than is allotted to it in the provisional schedule.

2. It seems to me that *physical chemistry* has not received the consideration it deserves. It is hard to tell, for instance, in which part of the catalogue the effects of ions should be mentioned. There is a sub-

division on isotony and other osmotic phenomena of the cell, and there is another subdivision in physiological chemistry on 'semi-permeability and physiological properties of colloids,' but I am at a loss to find where experiments on the osmotic properties of muscles or connective tissues, etc., could be properly catalogued. It seems to me that fuller provision should be made for the whole realm of the application of physical chemistry to physiology.

3. It seems to me, further, that provision should be made for the facts of physiological morphology. By physiological morphology I mean the energetics of the phenomena of organization. Physiology has thus far chiefly been a study of the phenomena of irritability. But there can be no doubt that phenomena of growth, irritability and metabolism are so thoroughly interwoven that neither metabolism nor irritability can be fully understood without taking into consideration the phenomena of growth. For instance, only the active muscle is able to undergo hypertrophia. The resting muscle atrophies. It is evident that contractility and growth are in some way connected. In plants the heliotropic and other curvatures are connected with the phenomena of growth. It is even possible that our inability to explain contractility is due to the fact that we have not yet taken into consideration the phenomena of growth. Furthermore, I do not quite see where in the present catalogue such experiments on physiological morphology as those on heteromorphosis (the experimental substitution of one organ for another) could be mentioned. Physiological morphology includes also the physiological analysis of heredity. The field of physiological morphology is wider and certainly more fundamental than the present physiology of nerves and muscles.

JACQUES LOEB.

UNIVERSITY OF CHICAGO.

SCIENTIFIC BOOKS.

Talks to Teachers on Psychology, and to Students on some of Life's Ideals. By WILLIAM JAMES. New York, Henry Holt & Co. 1899.

In his first chapter Professor James discusses the relation of psychology to the teaching art. We have so many statements from non-psychologists concerning what psychology may do for teaching that it is pleasant to hear what a psychologist himself has to say on the subject. In the first place, it is pointed out that sciences do not directly generate arts. The study of logic does not make a thinker, nor that of grammar a correct speaker; so the study, even the mastery, of psychology does not insure success in teaching. A science and its corresponding art can be brought together only by means of a mediator; that is, a mind full of tact and invention for the application of the rules of the science to the practice of the art. Given a skilful mediator, psychology can be of the greatest aid to teaching. This is especially true in this country, where the system is so elastic that it becomes a vast laboratory for educational experiment. To this advantage we have the concomitant circumstance of a body of psychologists anxious to instruct another body of teachers eager to learn.

Incidentally, in this chapter, Professor James attempts to allay the pangs of bad conscience in those teachers who have been made to feel that they must contribute to child psychology or be unworthy their calling. He heartily agrees with Professor Münsterberg that the psychologist's attitude toward mind must be abstract and analytical, whereas the teacher's should be concrete and ethical. Haunted by Emerson's lines—

"When duty whispers lo, thou must,
The youth replies, I can,"

the conscientious teacher is pained that she does not. But Professor James eases this pain by intimating gently that obligation is obviated by inability.

The second chapter contains an abridgement of Professor James's well-known description of the Stream of Consciousness, while the third and fourth chapters are devoted to conduct as the outcome of education.

Chapters five, six and seven show the nature and need of spontaneous and acquired reactions. This discussion is new, forceful and illuminating. Not all of these things can be said of the succeeding chapter on the laws of habit. This is taken almost bodily from the author's 'Psychology.' That it is brilliant and sound will be attested by many. Yet what shall we say of the man who can produce new books, but who simply copies his old ones verbatim in the most important parts? Professor Patten, in his 'Development of English Thought,' declares that geniuses are always lazy. Professor James can bear this double imputation, yet one can hardly excuse him when he says he needs to offer no apology for copying his own books. The apology is needless only because it is useless. An author should treat himself as well as he treats other authors. He would not incorporate their matter without transforming it by the force of his own thinking; no more should he repeat himself without subjecting his older thought to the transforming influence of a new point of view. Who wants to buy the same book twice?

The chapters on Interest and Attention are among the best and most typical in the book. The treatment is eminently popular and general, yet none the less helpful on that account. If it is much less rigid than that of Dr. Dewey, it is perhaps as useful to the ordinary teacher. The difference is that which exists between a diagram and a demonstration; the one is æsthetic, the other intellectual.

Apperception is described at some length in chapter fourteen, the discussion making no pretension to scientific exactness. Indeed, Professor James has always given the topic a step-motherly treatment, viewing the word *apperception* as a blanket term in psychology, and following the older traditional division into sensation, perception, memory, etc. Yet even from the standpoint of psychology itself, the researches of Wundt and others have shown that there are distinct advantages in treating apperception as an elemental process in psychic life; when we come to education the advantages of this procedure are great and unquestionable. It is to be hoped that Professor James will some day give his mind to a thoroughgoing scientific

exposition of the subject. If one may be permitted to cut out work for his neighbor, one may perhaps suggest to Professor James that a monograph upon apperception in its educative bearings would be gratefully received by American teachers.

Of the significance and value of this volume as a contribution to the cause of education there can be no question. Like everything that Professor James writes, it is at once lucid and interesting. If the treatment is popular and general, it is, at all events, founded on scientific insight, and, so far as it goes, may be confidently trusted as sound. If it ridicules 'brass instrument' study of children, it yet tends to awaken sympathy with childhood. If it disappoints the seeker after 'scientific' study of education, it, at least, satisfies the heart of the earnest teacher.

Finally, this book is to be welcomed because it shows that in educational theory, as in treatises upon subject-matter, the writing of books is passing from the hands of professional book-makers into those of the real leaders of thought. In this fact we find the brightest hope of our educational progress.

CHARLES DEGARMO.

CORNELL UNIVERSITY.

Wetterprognosen und Wetterberichte des XV. und XVI. Jahrhunderts. No. 12, Neudrucke von Schriften und Karten über Meteorologie und Erdmagnetismus herausgegeben von PROFESSOR DR. G. HELLMANN. Berlin, A. Asher & Co. 1899.

In this volume, which is the latest and largest of the series, Dr. Hellmann explains the origin and growth of weather predictions in almanacs, etc., and the practice in the different countries of describing remarkable meteorological phenomena, illustrating both subjects by *facsimile* reproductions of printed documents of the fifteenth and sixteenth centuries. As Dr. Hellmann remarks, the art of foretelling the weather has always been the object of meteorological research, but it has been practiced in various ways according to the theoretical knowledge that existed of the occurrences in the atmosphere. Among the Greeks, at the time of Meton, public placards announced the past and expected weather. Later, astrology controlled

the predictions in the almanacs, which were first printed in Latin and afterwards in the language of the country where they appeared. Such an almanac, the *Bauern-Kalender*, or peasants' calendar, having symbols to represent the predicted weather, is still published in the Austrian Tyrol. The custom of writing accounts of extraordinary meteorological events is very old, and, after the invention of printing, these reports, in pamphlet form or on single sheets, were widely distributed throughout Europe. As they were intended for the people, few have been preserved in libraries, but some of these are here reproduced.

The volume contains 33 pages of historical and critical introduction and 26 *facsimiles* of German, French, English, Italian, Spanish, Danish and Dutch tracts, most of them curiously illustrated. Probably to no other person than Dr. Hellmann would so many rare works in all parts of Europe be accessible, and his scholarly preface greatly aids the comprehension of these interesting specimens of ancient weather lore. One or two copies of the volume may be obtained for the publisher's price, viz., 20 Marks, or \$5, from the undersigned, at Hyde Park, Mass.

A. L. ROTCH.

BOOKS RECEIVED.

Proceedings of the Fourth International Congress of Zoology, Cambridge, 22-27 August, 1898. London, C. J. Clay & Sons. 1899. Pp. xiv + 422 and 15 plates. 15s. net.

Cinématique et mécanismes potentiel et mécanique des fluides. H. POINCARÉ. Paris, Carré et C. Naud. 1896. Pp. 385.

Alaska and the Klondike. ANGELO HEILPRIN. New York, D. Appleton & Co. 1899. Pp. x + 312.

Leitfaden der Kartenentwurfslehre. KARL ZÖPPRITZ. Leipzig, Teubner. 1899. Pp. x + 178. Mark 4.80.

Der Gang des Menschen. II part. OTTO FISCHER. Leipzig, Teubner. Pp. 130 and 12 plates. Mark 8.

Elektrische Untersuchungen. W. G. HANKEL. Abhandlung der mathematisch-physischen Classe der königlichen sächsischen Gesellschaft der Wissenschaften. Leipzig, Teubner. 1899. Vol. 24. Pp. 471-97 and 2 plates. Mark 2.

Practical Physiology. DR. BURGH BIRCH. Philadelphia, Blakiston's Son & Co. 1899. Pp. x + 273. \$1.75.

The Steam Engine and Gas and Oil Engines. JOHN PERRY. New York and London, The Macmillan Company. 1899. Pp. viii + 646.

Geological Results, based on Material from New Britain, New Guinea, Loyalty Islands and elsewhere, collected during the years 1895-7. Cambridge, The University Press. 1899. Pp. 356 and 5 plates.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Geology, April-May, 1899.—

H. F. Reid, 'The Variations of Glaciers,' pp. 217-225. Professor Reid presents the fourth of his summaries of observations on the advance and retreat of glaciers in different parts of the world. While recession is the rule, there are some instances of advance, and some evidence has been gathered of recurrent cycles of maxima and minima. In the case of two Swiss glaciers the periods proved, respectively, 44 and 51 years.

G. C. Curtis and J. B. Woodworth, Nantucket, 'A Morainial Island,' pp. 226-236. The former author describes a recently constructed model of Nantucket, and the latter its geology.

Mark S. W. Jefferson, 'Beach Cusps,' pp. 237-246. The small cusps along beaches are explained by the action of retreating high waves, whose waters breach the strip of seaweed that is usually present just above the line of ordinary waves, and that binds the shingle together. Between the breaches the cusps gather at intervals of ten to forty feet.

Walter D. Wilcox, 'A Certain Type of Lake Formation in the Canadian Rockies,' pp. 247-260. Interesting data are given regarding the glacial phenomena of the Canadian Rockies, and particularly regarding Lake Louise. A means of estimating the time since the retreat of the great ice sheet is suggested, but for lack of the necessary apparatus it has not been carried out.

J. P. Goode, 'The Piracy of the Yellowstone,' pp. 261-271. Recent changes in the drainage of Yellowstone Lake are described and explained. The Yellowstone River, as at present known, appears to be of development in late geological time.

C. E. Monroe and E. E. Teller, 'The Fauna of the Devonian at Milwaukee, Wis.,' pp. 272-

283. Recent excavations for the the Milwaukee water works have made available a large quantity of loose rock, which proves to be rich in Devonian fossils. These have been identified and tabulated by the authors.

H. S. Washington, 'The Petrographical Province of Essex Co., Mass.,' pp: 284-294. This paper on the basic dikes concludes the series.

Under 'Reviews' an excellent summary by T. A. Jagger is given of the recent valuable experiments of Morosewicz in the artificial production of rocks and minerals.

American Chemical Journal, June, 1899.—'The Valuation of Saccharin,' by E. Emmet Reid. By boiling for two hours with a hydrochloric acid solution of the proper strength and then distilling with alkali, the ammonia can be collected in a standard acid solution and readily determined. It was shown that para sulphamine benzoic acid was not acted upon under similar conditions. This, therefore, appears to be a quick, accurate method for determining the amount of the sweetening substance in the commercial saccharine. 'Some Derivations of Camphoroxime,' by G. B. Frankforter and A. D. Mayo. 'Camphoroxime Derivatives,' by G. B. Frankforter and P. M. Glasoe. 'The Laboratory Production of Asphalts from Animal and Vegetable Materials,' by W. C. Day. The author has obtained substances similar to the natural asphalts by distilling animal and vegetable matter, both separately and mixed. 'The Composition of Nitrogen Iodide and the Action of Iodine on the Fatty Amines,' by J. F. Norris and A. I. Franklin. The evidence points to the fact that the compound formed by the action of iodine on ammonia is not a direct addition-product, nor do the fatty amines form such compounds. 'On the Action of Sodid Ethylate on Tribromdinitro Benzol,' by C. L. Jackson and W. Koch. 'The Action of Sulphocarbonyl on certain Acid Anhydrides,' by F. L. Dunlap. 'The Action of Ammonia and Amines on Chlorides of Silicon,' by F. Lengfeld. The chlorine is replaced by the ammonia and amine residues, forming amides of silicon.

J. E. G.

APPLETON'S *Popular Science Monthly* for July has as a frontispiece an excellent portrait of Pro-

fessor W. K. Brooks, and the number contains a sketch of his life and scientific work. The number contains articles by President D. S. Jordan, describing the succession of fishes inhabiting a brook; by Professor W. K. Brooks, entitled 'Thoughts about Universities;' by Professor Edward Renouf, on 'Acetylene,' and by Dr. C. C. Abbott, on 'The Antiquity of Man in North America.'

WE regret that the *Index Medicus* has been discontinued. It is unfortunate that the efforts for its continuation have not been successful, but the mass of medical literature has become so great, and, it must be added, in most cases so unimportant, that an index would require some form of public support.

SOCIETIES AND ACADEMIES.

THE NEW YORK ACADEMY OF SCIENCES—SECTION OF BIOLOGY.

THE Section met on May 8th, Professor F. S. Lee presiding. The following program was then offered:

1. W. A. Rankin: 'The Crustacea of the Bermuda Islands, with Notes on the Collection made by the New York University Expeditions to the Bermudas in 1897 and 1898.'

2. H. F. Osborn: 'Upon the Structure of the Mule-footed Hog of Texas.'

'Upon the Structure of *Tylosaurus dyspolor*, including the Cartilaginous Sternum.'

Professor Rankin's paper gives a list of 61 recorded species of Crustacea from the Bermuda Islands. During the summers of 1897 and 1898 a party from the New York University spent a few weeks investigating the fauna of the islands, and the Crustacean collections were studied by the author.

Of the total number of species 43 were found by the expedition, and notes on their distribution are given. Eight of these species are new to the Bermudas, and two, *Nika bermudensis* and *Alpheus lancirostris*, are new species described and figured in this paper. The genus *Nika* is now for the first time recorded from the West Atlantic region.

The physical conditions of the islands are touched on, and the Crustacea are shown to be in the main similar to those found in the West

Indies and the adjacent coasts of America, though 18 have a more or less extended range over both hemispheres.

Professor Osborn reported upon the anatomy of the feet of a specimen of the well-known 'mule-footed hog' of Texas, recently presented to the Zoological Museum of Columbia, by Dr. Wickes Washburn. Externally the feet present the appearance of complete fusion of the third and forth toes. Internally, however, considerable differences are observed. In the pes the third and fourth metapodials and the first phalanges are entirely separated and normal, the second pair of phalanges are closely united, and the terminal phalanx is also closely united, so it has the appearance of a single element. The fusion is less advanced in the manus; here the metapodials, first and second phalanges are separate, one of the second phalanges being abnormally hypertrophied and a supernumerary element being inserted beneath it. The terminal phalanges are very firmly united into a single element, which holds the bones above it together. Some discussion followed, during the course of which Professor Bristol stated that a large number of experiments were being carried on at a Western ranch to ascertain the effects of breeding upon this peculiar variety. Professor Osborn remarked that this anomaly presented an interesting case of the persistence of a character which must have originated as a sport.

Professor Osborn's second paper included a description of the remarkably complete skeleton of a Mosasaur, recently mounted in the American Museum of Natural History. The skeleton was procured two years ago from the famous Smoky Hill Cretaceous beds of Kansas, through Mr. Bourne, and has been worked out with the greatest care. It is practically complete as far back as the 78th caudal, and the bones are approximately in position, including the fore and hind paddle and, what is more remarkable, the almost complete cartilaginous sternum, sternal ribs, epicoracoids. The species represents the largest type of American Mosasaur, *Tylosaurus dyspeltor* Cope. As illustrated by numerous photographs and drawings, the specimen throws a flood of new light upon the structure of the Mosasaurs. The principal

characters are the following: 7 cervicals, 10 dorsals connected with the sternum by cartilaginous ribs, 12 dorsals with floating ribs, one sacral and 72 caudals (out of a total number of 86), coracoids connected by broad epicoracoids having a transverse diameter of 22 cm. The sternum is triangular in shape, tapering posteriorly and having the general form of that in *Trachydosaurus*; there is no evidence of an episternum, the shoulder girdle in general being more degenerate than *Platecarpus*, in which an episternum has been observed. The fore paddles are smaller than the hind ones and include two co-ossified carpals. The fifth digit is somewhat enlarged and set well apart from the others. The hind paddle is slightly larger and very completely preserved. The tail is remarkable in presenting an upward curvature in the mid-region, which probably supported a prominent caudal fin, but it is not angulated as in *Ichthyosaurus*. The skull shows the presence of epipterygoids. The total length of the skeleton as preserved is a little over 270 feet; the estimated total length of the animal is 30 feet. In mounting, a single large panel has been used, the animal lying upon its ventral surface, with the paddles outstretched, the sides of the back bone curved in a graceful manner, exactly as originally imbedded in the matrix.

FRANCIS E. LLOYD,
Secretary.

THE NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY.

THE regular meeting of the New York Section of the American Chemical Society was held on Friday evening, the 9th inst., at the Chemists' Club, 108 West Fifty-fifth street, Dr. William McMurtrie presiding. The following papers were read: 'Apparatus for testing the Density of Cements,' by Morris Loeb, Ph.D.; 'The Determination of Sulphur in Bitumens,' by S. F. and H. E. Peckham.

The apparatus described by Dr. Loeb is a modification of the well-known method for determination of the density of powders by displacement of liquid contained in a flask, but by the system of calibration adopted and the use of a specially graduated burette the volume of liquid displaced is obtained by difference

between the amount added from the burette and an arbitrary volume contained between two marks on the neck of the flask.

Drawing out the liquid to the zero mark by a pipette enables one to make another and several successive determinations without cleaning out the apparatus until the flask is actually almost filled with the powdered cement, so that three or four determinations may be made in about ten minutes.

Messrs. Peckham's paper recommended the deflagration method for determining sulphur in bitumens, using about two parts bitumen to thirty parts of mixed sodium carbonate and potassium nitrate. Some discussion followed as to the possible loss of volatile sulphur compounds—mercaptans, mercaptids and sulpho ethers—but the amounts of these forms of sulphur were conceded to be extremely small and probably without appreciable effect on the behavior of an asphalt.

A report by the Committee on Patent Legislation was read by Major C. C. Parsons, with the recommendation that it should be brought before the members of the Society at large.

A report by Durand Woodman, Secretary and Treasurer, stated that nine regular and two special meetings had been held, at which thirty-seven papers were read. The average attendance at these meetings was sixty-five.

The expenses of the Section had been \$1.19 per member for the year. The membership numbers about 305.

The election of officers for the ensuing year resulted as follows: Chairman, C. F. McKenna; Secretary-Treasurer, Durand Woodman; Executive Committee, William McMurtrie, E. G. Love, G. C. Stone; delegates to the Scientific Alliance, E. E. Smith, M. T. Bogert.

A SPECIAL meeting of the Society was held on Saturday, May 27th, at 8:45 p. m., in the Assembly Room of the Chemists' Club.

Announcement was made by Dr. C. A. Doremus of the preliminary program of the Fourth International Congress of Applied Chemistry, to be held at Paris next year. The meetings will be held in the halls and amphitheatre of the new Sorbonne, and every important branch of applied chemistry will be covered.

The feature of the evening was a paper by Dr. H. W. Wiley on 'The Chemistry of Nitrication,' fully illustrated by lantern slides.

DURAND WOODMAN,
Secretary.

THE WASHINGTON BOTANICAL CLUB.

REGULAR meetings of the Club were held on May 3 and May 30, 1899. At the former the members participated in a symposium on the topic 'The Origin of Insular Floras.' Discussion was opened by Professor E. L. Greene, Dr. F. H. Knowlton and Mr. O. F. Cook. In the short notes which preceded attention was called to the discovery of *Asplenium ebenoides* in the District of Columbia, and proof sheets of Professor Bailey's 'New Encyclopædia of Horticulture' were exhibited.

The meeting of May 30th was devoted to a discussion of the more salient features of the District flora, several specimens being exhibited. The Club held a most enjoyable excursion on Decoration Day, to which other botanists were freely invited, visiting Plummer's Island, in the Potomac, and the neighboring Virginia shore.

CHARLES LOUIS POLLARD,
Secretary.

PROFESSOR DEWAR ON LIQUID HYDROGEN.

THE second lecture in connection with the Royal Institution's centenary was given by Professor Dewar on June 7th. Professor Dewar said, according to the report in the *London Times*, that he did not intend to take any long flight into the great work of the Royal Institution in the past, since that had already been done by his colleague. His object was rather to introduce his audience to a new instrument of research—that was to say, to liquid hydrogen. This he exhibited boiling gently in a vacuum tube immersed in liquid air, the access of heat being, by this precaution, greatly impeded. They would notice it was a transparent liquid, in which there appeared a whitish deposit. This consisted of solid air, and it was impossible to avoid its presence, because immediately the cotton-wool plug was removed from a vessel of liquid hydrogen the air of the atmosphere came under the influence of so low a temperature as to be at once frozen

solid. To prove that the liquid he was manipulating with such freedom was really liquid hydrogen Professor Dewar put a light to a small quantity, a brilliant burst of flame being the prompt result. Of its exceedingly small density he gave an idea by showing that a light material like cork would not float on its surface, but sank to the bottom as if it were lead. The lowness of its temperature he illustrated by a number of experiments. Thus a solid body immersed in it for a short time was shown to become so cold that the air round it was liquefied and ran off in drops, while when a tube containing liquid air was plunged into it the air immediately became solid. On this tube being lifted out again a double effect was seen, for the melting of the solid within it yielded liquid air, which was also formed by condensation on its outside surface. An empty vessel placed for a short time in the cold atmosphere just above this liquid, filled with solid air in the form of snow, soon melted into liquid. Oxygen in a sealed tube when lowered into it quickly became solid, and when lifted out it could be seen, as heat was absorbed, to assume first the liquid and then the gaseous form. A sponge of porous material, soaked in liquid hydrogen and brought into a magnetic field, apparently behaved as if it were magnetic. That, however, was due to the condensation of the oxygen of the air, which, of course, was magnetic, and, though an observer might in this way be easily deceived into thinking hydrogen magnetic, Professor Dewar said he was satisfied that it was nearly neutral or diamagnetic.

Speaking of the real temperature of this liquid, he said it had taken him nearly a year to come to a definite conclusion on that point because he could not get any two thermometers to agree. Pure platinum resistance thermometers gave 35° absolute (or 238° below zero Centigrade), one of the platinum-rhodium alloy 27° , while hydrogen itself in a gas thermometer gave 21° , a reading nearly identical with one obtained with a German-silver electrical thermometer. The last part of the lecture was devoted to the extraordinarily low vacua obtainable by the use of liquid hydrogen. Thus, by immersing one end of a closed tube in it for a short time and then sealing it

off in the middle, a vacuum was formed in the upper part which was substantially perfect, as was shown by the fact that the electrical charge could not be made to pass. In conclusion, Professor Dewar, after exhibiting several other beautiful experiments, including one to illustrate the rapidity with which gases were discharged into a vacuum, claimed that the liquefaction of hydrogen was a triumph for theory not less than for practice.

Lord Kelvin, in moving a vote of thanks to Professor Dewar for his brilliant, beautiful and splendidly interesting lecture, said that if those present wished to measure the importance of the occasion, let them think what Count Rumford, or Davy, or Faraday would have thought, could they have been present. They could not have hoped for their scientific dreams and prophecies to be so splendidly verified within the century. The end of experiment in research at low temperatures had by no means been reached, and perhaps in a few years substances yet unknown and more refractory than hydrogen would have been found which would bring the experimenter to within five degrees of the absolute zero.

AUTOMATIC SHIP-PROPULSION.

AUTOMATIC ship-propulsion is once more proposed, this time by M. Linden, Secretary of the Naples Zoological Station, according to Sr. Menard in *Cosmos* of December 17, 1898. He attaches elastic plates to the bow and stern of the boat, which act precisely as does the tail of a fish. They are bent by the pitching of the boat in a seaway, and the reaction of their forcible unbending, as well as that of their motion against the water while being bent, produces forward motion in the boat, in effect as the fish drives himself forward by springing its tail in lateral movements. Thus every motion of the boat on the surface of the waves produces greater or less acceleration.

The boat employed is stated to be four meters (13 feet) long, its driving plates 50 centimeters long (20 inches) and one-half that width. They are thicker at the point of support than toward their extremities, giving a proper flexure when pressed by the water into their impelling

curves. Other experiments have been made, also, at Berlin, which are thought to offer some encouragement, and it is suggested that such a plan may prove satisfactorily operative with large vessels.

The idea is, however, very old; no one knows where or when it originated. Some twenty-five years ago Mr. Gerner, a then well-known inventor and patent attorney, of New York, proposed a somewhat similar scheme, employing rafts or floats at the stern and on either side, which, with the rolling and pitching of the vessel, and the relative motion thus produced, should operate levers on board the vessel, and through them a system of mechanism which should drive a screw and thus impel the ship. Nothing came of it, however.

R. H. T.

REMEASUREMENT OF THE ARC OF PERU.

UNDER date of May 12th the Minister of Public Instruction and Fine Arts announced to the French Academy of Sciences the coming departure from Bordeaux, on the 26th of May, of M. Maurain, captain of engineers, and M. Lacombe, captain of artillery, for Quito. These two officers constitute a commission to visit the stations of the old arc of Peru, measured between 1786 and 1789 by Bouguer, La Condamine and Godin, with the view of a remeasurement of the arc and its extension so as to comprise from five to six degrees of latitude.

This action is hailed with pleasure by geodists everywhere. It is the direct outcome of the renewal of the suggestion for its remeasurement made at the last meeting of the International Geodetic Association, at Stuttgart, in October, 1898.

The proposition that the work should be soon undertaken was brought up by the American delegate, Mr. E. D. Preston, of the U. S. Coast and Geodetic Survey, at that Conference, and his action was interpreted to mean that if France would not undertake it some other nation, probably ours, would take steps towards the remeasurement of the arc whose revision is considered of such great importance to geodesy.

LELAND STANFORD JR. UNIVERSITY.

By the recent gifts of Mrs. Stanford, Leland Stanford Jr. University becomes the richest university in the world, far surpassing in its resources Harvard, Columbia or any foreign university. Situated where the development of civilization has been most rapid, and where its future promise is unlimited, under a wise and far-sighted administration, the University will become within a generation one of the greatest universities in the world. Correct details of the gifts and bequests of Senator Stanford, and of the gifts of Mrs. Stanford, will be of interest to readers of this JOURNAL.

The resources of the University consist of three great farms, aggregating 95,000 acres of land, deeded by Act of Legislature. On one of these farms, which constitutes the University Campus, buildings to the value of \$1,000,000 were erected before Senator Stanford's death. By his will the University received \$2,500,000 in cash, invested in interest-bearing bonds. During the litigation following his death Mrs. Stanford deeded to the University her own private fortune, amounting to about a million dollars. The bulk of his fortune was left by Senator Stanford by will to his wife, with the understanding between them that in case she survived him she would do all for the institution that he would have done. This wish she has carried out to the letter, although, as a matter of fact, idle litigation has prevented her from doing anything until very recently. By her recent gift she transferred the residue of the estate to the University, it being necessary to do this by deed of gift under the laws of the State. Mr. Stanford's purpose was a chivalrous one, emphasizing the equality of his wife in their mutual work. The property just turned over has a commercial value—judging from the revenue stamps put upon the deeds—of \$35,000,000. It would probably bring in the market about \$13,000,000. What its actual value may be only the future can determine. The income arising from this final gift is at present relatively small, as by agreement among the railroads, in bonds and stock of which it largely consists, the earnings are for a time to be used in freeing the property from debt and in making improvements.

SCIENTIFIC NOTES AND NEWS.

THE statue of Helmholtz, in the court of the University of Berlin, was unveiled on June 6th, in the presence of the German Emperor.

THE statue of Darwin by Mr. Hope Pinker, presented to Oxford University Museum by Professor Poulton, was unveiled on June 14th, with an address by Sir Joseph Hooker. The statue, which is of life-size and which somewhat dwarfs the figure of Newton, by the side of which it is placed, represents the philosopher in an attitude of meditation, his hands crossed on his breast.

DR. MILTON UPDEGRAFF, professor of astronomy in Missouri University, has been appointed, by President McKinley, professor of mathematics in the United States Naval Observatory.

THE Arago medal of the Paris Academy of Sciences was presented to Sir George Stokes on the occasion of his recent jubilee.

THE Council of the London Mathematical Society has awarded the sixth DeMorgan medal to Professor W. Burnside, F.R.S., for his researches in mathematics, particularly in the theory of groups of finite order.

MR. WILLIAM MARTINDALE was, on June 7th, elected President of the Pharmaceutical Society of Great Britain.

THE John Marshall prize for 1899 has been awarded to Jacob H. Hollander, Ph.D., associate professor of finance, for his publication entitled 'The Financial History of Baltimore.' The Marshall prize consists of a relief portrait in bronze of Chief Justice Marshall. It is awarded annually to a graduate of the Johns Hopkins University who has published the most important work in the department of history, politics and economics.

THE death, is announced, at the age of 74, of M. Nourisson, professor of philosophy at the Lycée Napoléon since 1858, and since 1870 a member of the Academy of Political Sciences.

DR. THOMAS O. SUMMERS, professor of anatomy at the St. Louis College of Physicians and Surgeons, known for his researches on yellow fever, died by suicide on June 19th.

THE United States Civil Service Commission

announces that it desires to establish an eligible register for the position of Scientific Aid, Department of Agriculture. Candidates are not required to appear at any place for examination, but should file statements with the Commission not later than August 1st. For the information of applicants the following statement is made, as received from the Secretary of Agriculture: (1) Applicants will be limited to graduates of colleges receiving the benefits of grants of land or money from the United States; (2) each applicant must file with the United States Civil Service Commission, Washington, D. C., a properly certified statement as to the length of time spent in college, the studies pursued, the standing in these studies, the special work it is desired to take up and the special qualifications for such work, and, finally, a thesis upon such special scientific subject as the applicant may select, or in lieu of this any literature on scientific subjects published over his own signature; (3) the length of time any Scientific Aid may serve in the Department is limited to two years; (4) the salary shall not exceed forty dollars per month.

THE Maryland Geological Survey has started investigations in forestry in coöperation with the Division of Forestry at Washington, and Mr. George B. Sudworth, of the U. S. Department of Agriculture, has been detailed to work in Maryland and has already completed a forestry survey of Alleghany county. This work will be gradually extended throughout the State as fast as the topographic maps are completed. The Maryland Survey has also started biological investigations in Maryland under the supervision of Dr. C. Hart Merriam, of the U. S. Department of Agriculture, who has detailed members of his staff to begin a study of the distribution of the faunas and floras of the western section of the State. This work will be carried on as an adjunct to the Geological Survey of the State, and reports upon the life zones and areas of the State will be published from time to time by the State Geologist.

THE members of the Maryland Geological Survey recently made an extended trip along the shores of the Chesapeake Bay, upon one of

the State steamers, for the purpose of examining the stratigraphy of the Neocene and Pleistocene formations, which are to be the subject of special study during the present field season. Professor W. B. Clark, the State Geologist, was in charge of the expedition, and he had associated with him Messrs. H. F. Reid, E. B. Matthews and G. B. Shattuck as well as other members of the Survey. Dr. Arthur Hollick, of Columbia University, who is to undertake some investigations in paleobotany for the Survey, was one of the party. The expedition occupied ten days, and the trip extended into the lower Potomac basin as well as to several of the rivers of the Eastern Shore of Maryland.

WE have already called attention to the excursion arranged by the Union Pacific Railway Company to visit the fossil fields of Wyoming. Invitations have been sent to about 300 geologists and paleontologists, each of whom may bring at least one assistant with him. The party meets at Laramie on June 19th, and will be under the general direction of Professor Knight, of the University of Wyoming. The railway has issued a popular illustrated account of fossils in Wyoming, which can be obtained by application to one of their offices.

MR. A. J. BALFOUR, the government leader in the House of Commons, on June 27th assured a deputation representing the Royal Society and the Royal Geographical Society that the Chancellor of the Exchequer, Sir Michael Hicks-Beach, was prepared to give substantial aid to the proposed Antarctic expedition.

It is reported in the daily papers that Dr. Nansen has resolved to enter the lists as an Antarctic explorer. Letters received in London from him state that he hopes to have an expedition organized and ready to start in 1902. He is at present engaged in preparing his plans, and will endeavor to shape them so that he may supplement the work which the British and German expeditions propose to accomplish. Dr. Nansen intends to go to Berlin for the International Congress of Geographers, and Sir Clements Markham and Sir John Murray will also be there to meet Professor von Drygalski, the leader of the German expedition. An Ant-

arctic conference will be held, at which a general plan of action can be decided upon.

MR. H. J. MACKINDER, reader in geography at the University of Oxford, has just left England in charge of an expedition, the object of which is to make a thorough study of Mount Kenia, in British East Africa. The *London Times* states that the expedition is partly subsidized by the Royal Geographical Society, though a very considerable portion of the funds is contributed by Mr. Hausburg, one of the members of the expedition. Mr. Mackinder is also accompanied by two competent Swiss guides and two taxidermists and collectors. The expedition is well equipped with instruments, cameras and other means of carrying on scientific work. Dr. J. W. Gregory, when he visited Mount Kenia, succeeded in attaining a height of 17,000 ft., and his observations proved that further investigation would certainly yield interesting scientific results. Mr. Mackinder and his party propose to camp at a height of about 16,000 ft., and from this as a base they hope to make a good map of the whole mountain, ascend to its summit, journey all around it, investigate its glaciation and its geology, and make ample collections of animals and plants. As the expedition goes to work under specially favorable conditions, interesting results are expected. Mr. Mackinder hopes to spend at least a month on the mountain, and expects to be back in England about the beginning of October.

It is intended that the first malaria expedition of the tropical medicine department of University College, Liverpool, should go to Sierra Leone in August. The expedition will be headed by Major Ross, and will include Dr. Sunnett, the demonstrator to the Liverpool school. The malarial season is at its height in August, and the conditions are then most favorable for research. Major Ross hopes to prove his theory that malaria is caused by the bites of a certain species of mosquito. The expedition will determine, by the methods which Major Ross employed in India, which are the malaria-bearing species in the locality chosen, and then inquire whether it is possible, by filling up the particular puddles in which they breed, to exterminate malaria in a given district.

It has been decided that the Imperial School for the Study of Tropical Diseases, the establishment of which is due to the suggestion of Professor Koch, is to be settled at Hamburg. Professor Koch originally wished to have it in Berlin, but reasons of convenience have led to the substitution of Hamburg, where patients can be landed directly. The institution is for the present to be equipped to receive 30 patients.

MAJOR RONALD ROSS, I.M.S., inaugurated his first course of lectures on Tropical Medicine at University College, Liverpool, on June 12th, by an address on the 'Possibility of Extirpating Malaria,' in which he dealt in detail with the means of exterminating malaria-bearing mosquitos.

A REPRESENTATIVE of Reuter's Agency has had an interview with Doctor Henryk Arctowski, the Polish mineralogist and geologist of the *Belgica* Antarctic expedition. The *Belgica* expedition entered the Antarctic circle from the opposite direction to that in which the British expedition under Mr. Borchgrevink is now working, Lieutenant Gerlache, with the *Belgica*, going *via* Cape Horn and the South Shetland Islands, while the British expedition started from Hobart for Victoria Land. Dr. Arctowski said that their first object was to make a voyage in the Antarctic, but beyond this there was on starting no definite program. It was intended to examine the various scientific conditions. On leaving Staten their object was to go direct to the south and to explore in the region of Grahamsland and Palmer Land, on which no landing had been made since their discovery, in the early part of the century. On February 13th, four weeks after leaving Staten Island, they left the newly-discovered land which they named Danco Land and in three days sighted Alexander I. Land. On the 28th the *Belgica* ran into the Antarctic ice pack. The temperature fell and the *Belgica* stuck fast. For a whole year she remained immovable, and for the first time human beings prepared to spend a winter in the Antarctic. They had quite expected to winter in the south polar region, but they had hoped to do so on land. For that purpose they had everything prepared,

as it was their intention to build an observatory and depôt. They were, however, quite unable to find land on which to establish a depôt, and had to remain on the ship. The Antarctic winter lasted two months, but owing to the bad weather that prevailed they did not see the sun for three months. They spent the winter in scientific work. All of them suffered a good deal during the Antarctic night, owing to defective circulation and heart trouble. All pulled through except Lieutenant Danco, who succumbed to heart failure in June of last year, and his remains were buried beneath the ice. The only other member of the expedition to lose his life was Carl Wiencke, a Norwegian sailor, who was lost overboard between Staten Island and the Antarctic. At the beginning of the present year they began cutting a channel through the ice for the *Belgica*. After much hard work they cut a passage 900 meters in length, the ship got free of ice on March 14th last. As soon as they got free of the ice they steamed direct for Cape Horn, and reached Punta Arenas, Patagonia, on February 27th. The scientific results were satisfactory and were quite what was expected. Unlike the Arctic the Antarctic has no animals. The only signs of life found on land were a number of very small insects, which were discovered among the penguin rookeries. In the water there was plenty of life. There were far more seals than in the north polar regions, a great quantity of small whales and an abundance of penguins. The Antarctic land they found to be entirely mountainous, absolutely glaciated—covered with snow and ice. In some places, where the cliffs were too precipitous for ice and snow to lodge, lichen and moss were found. Dr. F. A. Cook, of Brooklyn, surgeon and anthropologist of the expedition, has returned to New York and has given similar accounts to the press.

UNIVERSITY AND EDUCATIONAL NEWS.

By the will of the late R. C. Billings, of Boston, Harvard University, The Massachusetts Institute of Technology and the Boston Museum of Fine Arts each receive \$100,000 and an additional \$50,000 is given to the Massachusetts Institute of Technology for scholarships. The

will also contains a large number of bequests to hospitals and other charitable institutions.

At the commencement exercises of Brown University it was announced that \$77,000 had been received in gifts, the names of the donors being in most cases withheld.

DR. D. K. PEARSON has given \$125,000 to Olivet College.

At the annual commencement at Oberlin College it was announced that, in addition to the gift of \$50,000 for a chemical laboratory, two other sums of \$50,000 have been given, the names of donors being withheld.

In view of the bequest of \$50,000 for the department of astronomy at Smith College by the will of Eliza Haven, won after long litigation, it has been decided that the department shall be known as the Elizabeth Haven School of Astronomy.

THE following summary of students for the years 1898-'99 is taken from the catalogue just issued by the University of Minnesota:

Graduate students.....	195
Undergraduates; College of Science, Literature and the Arts.....	898
College Engineering and Mechanic Arts	151
The School of Mines.....	62
The School of Chemistry.....	9
Department of Agriculture.....	409
College of Law.....	447
Department of Medicine.....	475
Summer School for Teachers.....	380
	3,028
Counted more than once.....	101
Total.....	2,925
Total instructors.....	266
Students to each instructor.....	12

It has been decided to found a chair of pathological anatomy in the Laval University, Montreal. The list of subscribers to the fund which is being raised for the purpose is headed by the Archbishop of Montreal.

DR. C. W. SUPER has been re-elected President of Ohio University. He occupied the position twelve years previous to 1896, when he declined re-election.

DR. E. B. MATTHEWS has been advanced to the position of associate professor of petro-

graphy and mineralogy, and Dr. G. B. Shattuck to the position of associate in physiographic geology, at Johns Hopkins University. In the Medical School Dr. L. F. Barker has been promoted to be associate professor of pathology, and Dr. R. G. Harrison to be associate professor of anatomy.

MR. JOHN L. VAN ORNUM, a graduate of the University of Wisconsin with the degree of B.S. in Civil Engineering, has been appointed professor of civil engineering in Washington University, where he has been for three years instructor. Mr. Van Ornum has lately been major of the Third U. S. V. Engineers.

MISS FLORENCE M. LYON, PH.D. (Chicago), has been appointed assistant in botany, and Miss Annie I. Barrows assistant in zoology, at Smith College.

Of the twenty-two fellowships awarded in the Johns Hopkins University the following are in the sciences:

- William Martin Blanchard, of Hartford, N. C., A.B., Randolph Macon College, 1894. Chemistry.
- Charles Edward Caspart, of Baltimore, A.B., Johns Hopkins University, 1896. Chemistry.
- Luther Pfahler Eisenhart, of York, Pa., A.B., Pennsylvania College, 1896. Mathematics.
- Lawrence Edmonds Griffin, of Hamline, Minn., A.B. and Ph.B., Hamline University, 1895. Zoology.
- Joseph Cawdell Herrick, of Virginia, A. B., University of Virginia, 1896. Physiology.
- Charles A. Kraus, of Lawrence, Kan., S.B., University of Kansas, 1898. Physics.
- Harry Taylor Marshall, of Baltimore, A.B., Johns Hopkins University, 1894, and M.D., 1898. Pathology.
- John Charles Olsen, of Galesburg, Ill., A.B., Knox College, 1890. Chemistry.
- Herbert Meredith Reese, of Baltimore, A.B., Johns Hopkins University, 1897. Physics.
- George Burr Richardson, of New York City, S.B., Harvard University, 1895. Geology.
- Richard Burton Rowe, of Clarksville, N. Y., Ph.B., Union College, 1896. Geology.

DR. H. M. MACDONALD, of Clare College, has been appointed University lecturer on mathematics at Cambridge University in the place of Professor Love.

At Oxford University Dr. Herbertson has been appointed lecturer in physical geography.

